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ABSTRACT

Among the most influential findings from the World Fertility Survey (WFS) were those linking fertility patterns to child survival, in particular the findings concerning the high infant and child mortality for children born after a short birth interval. This study examined the relations between fertility and child survival based on more recent data from the United Nations Demographic and Health Surveys of 25 developing countries. In the first part of the study, tabular analysis was used to assess the excess risks of child mortality associated with child-bearing too early or with short intervals between births. The second part used multivariate analysis in order to examine how far the differences observed are affected by a range of controls, such as mother's education, father's education, father's occupation, and place of residence. Results indicated that children born to mothers under age 18 are 46 percent more likely to die before age 5 than children born to mothers age 20 to 34 (similar to the earlier WFS); that children born less than 18 months after a previous birth are more than twice as likely to die as children born after a 2 to 4 year interval (this risk rate is similar to WFS results, although the incidence of such births has generally decreased); that maternal education appears to be a very powerful and pervasive correlate of child survival; and that for several countries there are striking indications of regional differences in child survival. (Contains 46 tables and 19 references.) (EV)

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The Health Rationale for Family Planning: *Timing of Births and Child Survival*

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Department for Economic and
Social Information and Policy Analysis
Population Division

The Health Rationale for Family Planning: *Timing of Births and Child Survival*

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NOTE

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The term "country" as used in the text and tables also refers, as appropriate, to territories or areas.

In some tables, the designations "developed" and "developing" economies are intended for statistical convenience and do not necessarily express a judgement about the stage reached by a particular country or area in the development process.

The views expressed in the report are those of the author and do not imply the expression of any opinion on the part of the United Nations Secretariat.

The report has been edited and consolidated in accordance with United Nations practice and requirements.

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PREFACE

Among the most influential findings from the World Fertility Survey were those linking fertility patterns to child survival, in particular the findings concerning the high infant and child mortality for children born after a short birth interval. These findings played an important part in setting the agenda for the International Conference on Better Health for Women and Children through Family Planning, held in Nairobi in October 1987. The health rationale of family planning for women and children was also stressed in the Plan of Action adopted at the World Summit for Children in New York in September 1990.

The results from the World Fertility Survey relate to the 1970s and earlier. The present study has been undertaken to examine the relations between fertility and child survival in the 1980s, a decade when the movement for child survival became important, and to formulate policy guidelines based on more recent findings. In the first part of the study, tabular analysis is used to assess the excess risks of child mortality associated with child-bearing too early or with short intervals between births. The second part uses multivariate analysis in order to examine how far the differences observed are affected by a range of controls, such as mother's education, father's education, father's occupation and place of residence. The study uses data from the Demographic and Health Surveys and covers 25 developing countries. Preliminary results of the first part of this study, covering 18 countries, were published in the *Population Bulletin of the United Nations*, No. 33 (Hobcraft, 1992).

The United Nations wishes to thank John Hobcraft of the London School of Economics and Political Science, who wrote the report. Special acknowledgement is also due to the United Nations Population Fund (UNFPA) for its generous support, which made this publication possible.

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Explanatory notes

Symbols of United Nations documents are composed of capital letters combined with figures.

The following symbols have been used in the tables throughout this report:

Two dots (..) indicate that data are not available or are not separately reported.
An em dash (—) indicates that the amount is nil or negligible.
A hyphen (-) indicates that the item is not applicable.
A minus sign (-) before a number indicates a decrease.
A point (.) is used to indicate decimals.
A slash (/) indicates a crop year or financial year, e.g., 1988/89.
Use of a hyphen (-) between dates representing years (e.g., 1985-1985), signifies the full period involved, including the beginning and end years.

Details and percentages in table do not necessarily add to totals because of rounding.

Reference to "dollars" ($) indicates United States dollars, unless otherwise stated.

The term "billion" signifies a thousand million.

The following abbreviations have been used in this report:

CPS	Contraceptive Prevalence Survey
DHS	Demographic and Health Survey
NDS	National Demographic Survey
PES	Post-enumeration Survey
WFS	World Fertility Survey

EXECUTIVE SUMMARY

During the past decade, particularly as a result of analyses of the information collected under the auspices of the World Fertility Survey (WFS), there has been a major accumulation of evidence that confirms and elaborates associations between the timing of births and the survival chances of the child. Teenage child-bearing, especially before age 18, has been shown to be associated with increased risks of child death. Of even greater importance is the strong association of short intervals between births with excess child mortality risks. These results played an important part in setting the agenda for the International Conference on Better Health for Women and Children through Family Planning held at Nairobi in 1987. It has often been suggested that substantial reductions in the incidence of these high-risk births could reduce child mortality by up to 30 per cent, especially in Latin America and the Arab countries, where intervals between births were generally short. Moreover, concerns have also been raised that a reduction of typical intervals between births in many sub-Saharan African countries, as a result both of shorter periods of abstinence from sexual relations following a birth and of shorter durations of breast-feeding, could lead to increased risks of child death.

The data from WFS cover the 1970s and earlier and are thus becoming less relevant to the 1990s. The decade of the 1980s covered dramatic fertility change, especially through increased use of reliable methods of contraception. In some countries, at least, there are clear indications of significant changes in the timing of births, including the incidence of teenage motherhood and the fraction of births that occur within two years of the preceding birth. How far have these changes in the timing of births altered the strength of the relationships observed for the 1970s? What has been the consequent mortality reduction from alterations in the timing of births?

Moreover, the 1980s have seen dramatic changes in the coverage of child survival measures, including extended immunization and the use of oral rehydration salts for treatment of diarrhoeal episodes. How far have these child survival programmes altered the patterns of excess mortality risk for those births which occur too early or too soon after the preceding birth?

During the latter half of the 1980s, a further major programme of retrospective surveys, known as Demographic and Health Surveys (DHS), were conducted in some 25 developing countries. The results from those surveys are used here to explore further the issues outlined above. Since there is considerable interest in comparing results over time in order to establish whether changes are taking place, it is useful to carry out much of the analysis in a form that enables comparisons to be made with the results from WFS. However, DHS also provides opportunities to pursue new questions, which either could not be answered using WFS data or have arisen as more recent concerns. This study includes many such comparisons and extensions.

Data and methods

Throughout this study results are presented for 25 countries which took part in the DHS programme. From the Americas, information is available for Bolivia, Brazil, Colombia, the Dominican Republic, Ecuador, Guatemala, Mexico, Peru and Trinidad and Tobago. The Northern African countries are Egypt, Morocco and Tunisia. From sub-Saharan Africa the study encompasses Botswana, Burundi, Ghana, Kenya, Liberia, Mali, Senegal, Togo, Uganda and Zimbabwe. Indonesia, Sri Lanka and Thailand are the only three countries included from Asia. The fieldwork for those surveys was carried out at various times, some as early as 1986, and the latest in 1989 (table 1).

DHS contain information that enables the calculation of child survival measures covering several years before the dates of the surveys. In this study, most analyses cover children born up to 15 years before the surveys to mothers who were under age

35 at the time of the birth, with sample sizes ranging from just under 5,000 births to nearly 25,000. Births to women over age 35 at the time of the birth were omitted because the design of DHS effectively precludes their inclusion. Multiple births are excluded from the analyses. DHS also enable the calculation of the age of the mother at the time of each birth, the order of the birth, the time since the preceding birth, and a welter of other such indicators. Moreover the surveys also include a number of socio-economic characteristics of the mother, her husband (or partner) and of the household.

The report comprises two parts. In part one, results are presented in a tabular format. This form of analysis has the benefit of simplicity and is more readily comprehensible. But tabular analysis also has potential drawbacks, since the observed relationships might be spurious owing to a failure to control for other key variables. In order to protect (partially) against such spurious findings, part two of the report introduces a series of multivariate analyses which address the important topic of the interplay among several of the factors associated with child mortality.

Results from tabular analyses

Compared with births to mothers aged 20-34 years, children borne by mothers aged under 18 years are shown to be 46 per cent more likely to die before age five (using a simple unweighted average across all 25 countries); children born to mothers aged 18 or 19 experience a 16 per cent average excess risk. If all of this excess risk were entirely due to teenage motherhood (rather than associated factors), the mortality of first births might be reduced by an average of 21 per cent across the 25 countries if all births to teenage mothers were eliminated; these maximal "potential" gains exceed 35 per cent in several countries (Dominican Republic, Egypt, Mexico and Peru). But births to teenage mothers comprise a smaller fraction of all births than of first births, and elimination of teenage births could only lower overall child mortality by a few per cent at most. The results from DHS and WFS are very similar, suggesting little change over time (tables 2 and 3).

Children born shortly after a previous birth experience considerable excess mortality risks. Where the interval from the previous birth is less than 18 months, the average risk of death before age five is more than doubled compared with a birth occurring two to four years after the preceding one (it is noted that some of this excess arises from a higher than average incidence of prematurity among births at such short intervals). Where the preceding interval is 18-23 months, the average excess risk is about a third. The unweighted averages across all 25 countries naturally hide variability. The relative excess risks are especially low for a number of sub-Saharan African countries (Burundi, Ghana, Liberia, Senegal and Togo), though these are countries where mortality levels are high, resulting in considerable absolute excess risk. The excess risks of child death associated with short birth intervals are especially high in Egypt, Tunisia, Botswana, Brazil and Guatemala (table 4).

If all the observed excess mortality for short birth intervals arose entirely from the birth interval rather than from other factors associated with the birth intervals (unlikely) and all births at intervals of shorter than two years were eliminated, overall child mortality levels might be reduced by about 17 per cent on average across the 25 countries and by as much as a third for Brazil and Egypt.

The pattern of excess risk associated with short birth intervals appears to have changed little over time, since the results from WFS and DHS are very similar. However, both for individual countries and on average, the fractions of poorly-spaced births (those at intervals of less than two years after the previous birth) generally reduce between WFS and DHS. For example, 58 per cent of all second and higher order births in Colombia occurred at intervals of less than two years after the previous birth for the 15 years preceding WFS; for the 15 years preceding DHS this fraction had reduced to 43 per cent. This translates into a 12 per cent overall reduction in child mortality for second and higher order births purely as a result of improved child-spacing in Colombia over about a 10-year period, a significant gain. On the other hand, the fraction of such births at short

intervals in Senegal rose from 22 per cent to 26 per cent over about eight years (tables 4-8).

The more detailed information recorded in DHS enables the first empirical study of the impact of date imputation on the observed association between length of birth interval and child mortality. Perhaps surprisingly, the results provided indicate that even quite extensive uncertainty about the reported dates of birth and death of children does little to distort the association between short birth intervals and excess child mortality. This robustness to recorded reporting errors is reassuring and removes one of the doubts about spurious association which has been persistently raised in the literature (tables 9 and 10).

The analyses by age of mother and length of preceding interval are brought together by using a ten-fold "family formation" pattern, which echoes earlier studies using data from WFS. All births to women under age 35 excepting multiple births were (cross-) classified according to four criteria: whether they were first births or not ("later" births); whether they were to teenage mothers or not; for later births, a sub-division into those born after a short interval (less than two years) or not; and finally, for later births which were not to teenage mothers, an indication of the overall "pace" of child-bearing (slow, medium and fast) was introduced in order to address the question as to whether a concentration of births in a short time, over and above a short preceding interval, is associated with excess child mortality.

Risks of child mortality associated with the 10 "family formation" groups were assessed by contrasting child mortality for any specific group with the overall level for a "reference group" of second and higher order births to women aged 20-34 years which were "well-spaced" (intervals of two or more years). The average mortality risks before age five were greatest for the poorly-spaced births, being as much as two and a quarter times that for the reference group when these occurred to teenage mothers or to those aged 20-34 with a fast pace of previous child-bearing. When the previous pace was "medium" the average mortality excess was 82 per cent; when it was "slow" this average excess was 44 per cent. First births to teenage mothers also experienced a 47 per cent average excess mortality risk before age five. Even well-spaced births to teenage mothers (clearly a fast pace) experienced a 35 per cent overall excess child mortality.

Brazil and Egypt stood out as having especially high excess risks for teenage and for poorly-spaced births and Thailand and Tunisia also show very high excess risks for poorly-spaced births. The relative excess risks were small in Senegal and Togo and fairly low in Burundi, Ghana and Liberia, although the absolute excess mortality was high for these countries, given their overall high levels of child mortality.

Once again, the patterns of excess risk are similar in WFS and DHS, suggesting that health interventions have failed to alter the excess risks with the timing of births. Indeed, if anything, the excess risks associated with poorly-spaced births and with well-spaced teenage births seem to have worsened slightly over time. However, patterns of births across the family formation categories have changed considerable in a number of countries. For example, in Colombia about a quarter of observed child mortality gains over the 10 years from WFS and DHS may result from improvements in the timing of births. In contrast, without the adverse changes in the timing of births in Senegal, child mortality gains over the eight years period might have been 50 per cent greater. Clearly, there is evidence in both directions that changes in the timing of births over quite short periods can exert a notable effect upon the extent of change in child mortality (tables 11-15).

A simpler summary analysis is also undertaken, with all singleton births to mothers aged under 35 years at the time of the birth being allocated to three broad risk groups. The "low" risk group comprises first births and well-spaced later births for mothers aged 20-34 years. The "intermediate" risk group includes first and well-spaced subsequent births to teenage mothers and slow-paced poorly-spaced births to mothers aged 20-34 years. The "high" risk group is composed of poorly-spaced teenage births and poorly-spaced medium and fast-paced births to mothers aged 20-34 years. The low risk group can thus be seen as a feasible policy prescription, since encouraging delayed entry into motherhood (age 20 or later) and well-spaced subsequent births (intervals of

at least two years) is widely regarded as desirable. This low risk group is used as reference point for comparisons of mortality risks in the other groups and in the population as a whole.

To obtain a broad picture of the results, the unweighted averages across all 25 countries are considered first. Overall, 57 per cent of births are in the low risk category. The 24 per cent of births in the intermediate risk category experience an excess risk of child death of 43 per cent. The 19 per cent of children born in the high risk category are just over twice as likely to die before age five as those in the low risk group. The overall consequence is that mortality of all births is nearly a third higher than for the low risk group. If this excess were entirely due to the timing of births, rather than to other correlated factors, a 30 per cent reduction in child mortality could in principle be achievable through avoidance of teenage births and poorly-spaced births.

There has been a reduction over time in the fraction of births in the high risk group, with the average across 18 WFS countries being 25 per cent, compared with the 19 per cent for the 25 DHS countries. The fraction of low risk births increased concomitantly, from 52 to 57 per cent. However, these gains in the timing of births have been offset by a worsening of the excess risks, from 38 to 43 per cent for the intermediate group and from 89 to 106 per cent for the high risk group. As a consequence of these countervailing forces, the overall excess child mortality for all births compared with the low risk ones remained almost constant, at about 30 per cent.

The most striking excess mortality risks appear for Brazil and Egypt, where the overall level of child mortality exceeds the value for the low risk group by about two thirds (73 per cent for Egypt and 64 per cent for Brazil). In these two countries children born in the intermediate risk group have about twice the risk of dying before age five of those in the low risk group; for the high risk births the risk of death by age five is tripled. In the unlikely event that all of the observed excess child mortality is attributable simply to the timing of births the policy message would be simple and dramatic: elimination of teenage and poorly-spaced births during the 15-year period covered would have meant that child mortality in Brazil would have averaged 60 per 1,000 births, rather than the observed 99 per 1,000; for Egypt, the corresponding reduction is from 147 to 85 per 1,000. If even half of these gains are attributable to the timing of births, rather than other related factors, the health gains for children from improved patterns of childbearing would still be substantial.

For the other countries of the Americas and Northern Africa, the overall risk of child death exceeds that for the low risk group by about 30-45 per cent, resulting from fairly high excess risks and significant fractions of births in the high risk groups. The overall excess child mortality is lower among the Asian and sub-Saharan African countries included in the study, ranging from about 10 to 30 per cent. These countries typically have relatively few poorly-spaced births, largely as a result of prolonged breastfeeding, and several of the high mortality sub-Saharan African countries also show lower relative excess risks for the high risk births (tables 16-19).

Multivariate analyses

The second part of the report considers a series of five regression models applied to each of the 25 countries covered by the study, and it is concerned with the interplay among the correlates of child mortality, including various measures of the timing of births and a range of socio-economic and related factors. Each of the regression models covers all singleton births to mothers aged less than 35 years at the time of the birth, over the period 2 to 15 years before the survey. In each case the dependent variable is whether the child in question survived to age two, and logistic maximum likelihood models are used. The first three models are near replications of those used in major comparative analyses of WFS data, in order to provide comparable results to enable assessment of whether relationships have altered over time. The final two models extend the analysis into new domains, separating first and subsequent births and introducing a wider range of correlates.

The first model is called the "counts of births" model, since its prime purpose is to assess whether the density of births in segments of time before the

birth of a particular child (often referred to as the "index" child) is associated with differing risks of child death. Counts of births in the two years before the index birth (poor-spacing) and in the preceding four years are included in the analysis, as are controls for first births and the mother's years of schooling. This model demonstrates the strong effect of poorly-spaced preceding births but also formalizes some of the results on pace of child-bearing from the first part of the report. The results are very similar to those from the earlier analysis of WFS material, suggesting little change in patterns of excess risks associated with the timing of earlier births (tables 20-25).

The second model is referred to as the "bio-demographic" model. This model is concerned with the interplay among child-spacing, the age of the mother, birth order, sex of the child and mother's education. It also includes a further control for the survival status of the preceding birth, which proves a crude but effective indicator of death clustering within the family (tables 26-30).

The third model is concerned entirely with the interplay among several "socio-economic" correlates of child mortality, including mother's years of schooling, father's years of schooling and broad occupation group and region of residence. Although this purely socio-economic model is not directly concerned with the timing of births, the main preoccupation of this report, it helps to clarify the interplays among such variables and provides indications of their relative importance as controls for the subsequent analyses. The results are also important in their own right (tables 31-36).

The fifth and final model is restricted to "later births" (i.e., not first births), where much more information is available concerning the timing and survival status of preceding births. This model examines the interplay among: the preceding birth interval; the mother's age at the birth and birth order; the survival status of the preceding birth and numbers of deaths among earlier births; the sex of the child; the mother's years of schooling and region of residence; and time trends. This model therefore addresses interplays within and between groups of variables indicating socio-economic status, bio-demographic aspects of the timing of births, and clustering of death within families (tables 42-46).

The results for each model are discussed at length in the report. Since there is some overlap in the correlates used for the different models the results are here summarized by topic, beginning with the correlates other than the timing of births and then turning to the main focus of this study.

The other correlates

In all the models considered, maternal education appears as a very powerful and pervasive correlate of child survival. Net of the other factors considered in the various models, universal provision of seven or more years of schooling might lower overall child mortality by a maximum of about 40 per cent (if all of the maternal education differentials were a direct result of schooling).

Consistent and new evidence strongly suggests that the advantages of having an educated mother are weaker in the sub-Saharan African countries included in this study than elsewhere. Indications are also provided that the potential population level gains from universal provision of seven or more years of schooling might be greatest (about 50 per cent) in the Northern African region, where educational levels were low and differentials fairly high. Moreover the association of child survival with maternal education remains strong in the face of a wide range of other controls, most notably in the socio-economic model where the gross associations with the husband's characteristics (education and occupation) are weaker than with maternal education and the attenuation of the net effects is also much greater for the husband's characteristics than for maternal education.

For several countries there are striking indications of regional differences in child survival. If all regions could achieve the mortality experience of the region with the lowest level of child mortality within each country, there might be an average net maximal reduction in child mortality of about 30 per cent. Regional variations in child survival are even more pronounced for first births. Regional variations are presumed to have arisen in significant measure from

differential health provision and to lesser extent from variations in disease ecology. These clear patterns are contrasted with results from WFS which suggested very little variation in child survival by type of place of residence.

The net time trends showed considerable variation among countries, but the net impact over a 10-year period averaged a 22 per cent reduction in child mortality, not captured by any of the other factors controlled.

The model restricted to later births (i.e., those after the first birth), addresses the question of clustering of births within the family in a novel and direct way which is potentially relevant to obstetric and post-natal care. Fairly clear indications are found of increased risk of death for a child if any of its older siblings have died. Clear support for major clustering of deaths within families is not found, since the cumulative effect of more than one preceding death on the survival chances of a child is not evident. At the population level, all of the information on death clustering accounts for an average net 10 per cent excess child mortality. There is also some indication that knowledge of a death of the immediately older sibling, before the birth of the index child, conveys more information about the survival chances of a child than does an indication of a death of even older siblings. It is speculated that this recency phenomenon could arise either through a rapidly improving general child survival environment (which the estimated and partially controlled time trends strongly suggested for several countries) or in part because the death of the immediately preceding birth contributed more directly to the mortality of the index child through inducing a short birth interval. These issues of death clustering merit further careful exploration.

The timing of births

Teenage child-bearing, especially before age 18, is shown to be generally associated with excess child mortality. The excess risk for individual births is considerable, but no larger than that associated with moderately short birth intervals (of 18-24 months), and the proportions of births to very young mothers are not usually very high. As a consequence, a delayed entry into motherhood may help individual mothers to lower the risks of having their first child die (and may have subsequent reproductive benefits which are not investigated here), but such a policy should not be expected to have a major impact on child survival at the population level, since the maximal average gain is about 6 per cent; for first births this maximal average net potential gain is about 13 per cent. Of course, there are other motives for advocating a delayed entry into motherhood, such as increasing female autonomy.

Once other factors are controlled, birth order does not emerge as a powerful correlate of child mortality. This again reinforces the results from WFS studies that the excess mortality associated with "too many" births is weak for the child, compared with other more powerful correlates. (Of course, since each pregnancy and birth carries a risk of maternal mortality, avoidance of many births constitutes an important health rationale for family planning for mothers.)

The spacing of births once again emerges as the most powerful and consistent correlate of child mortality among the elements of the health rationale for family planning. As was found from WFS, the strong and very widespread association of short preceding birth intervals with raised mortality risks persists in the face of the wide range of controls introduced in the regression analyses. The net overall average maximal gain in child mortality from elimination of short birth intervals is estimated to be about 21 per cent (a 26 per cent net excess).

The patterns of association with broad regional groupings identified in part from WFS studies are confirmed and sharpened by this study. The Northern African countries are shown consistently to have large excess risks for poorly-spaced births and high proportions of births at risk. This combination results in very considerable excess mortality at the population level (about 44 per cent net of other factors). Latin American countries also have considerable fractions of births which occur at intervals of less than two years after the preceding one combined with fairly high excess risks, resulting in quite substantial excess child mortality at the population level

(about 30 per cent net of other factors). Patterns of birth-spacing are typically better in the Asian countries and in the sub-Saharan African countries and excess risks are also somewhat lower in several sub-Saharan African countries. As a consequence, the countries covered in these regions show only moderate, though by no means trivial, net excess child mortality associated with short birth intervals (about 20 per cent at the population level).

Policy implications

Since interventions to improve levels of female education are desirable on several other grounds (e.g., to improve women's status and, quite likely, help to lower fertility), the nearly universal findings on association with child survival reinforce the importance of improving (and especially not dismantling) education systems. However, this study shows that there are likely to be significant gains in child survival from universal provision of seven or more years of schooling for women.

Much more needs to be discovered about the pathways through which maternal education improves child health. Moreover and relatedly there is a need to discover whether and how far the key benefits for child survival can be conveyed to those women with fewer years of schooling, whether inside or outside the formal education sector. Regrettably, the data from DHS do not permit any attempt to discover the roles of differing content of the curriculum or of informal education, especially on health.

There are also striking net variations in child mortality by regions within countries. Some of these contrasts arise from differing disease ecologies but it is likely that divergences in health provision and infrastructure play an important role. Substantial gains in child mortality can be achieved through improvements in these regional disparities.

While there is still a need to understand the mechanisms involved, a massive body of evidence has accumulated over the past decade, significantly reinforced by this study, to indicate a clear, pervasive and strong excess risk of death for children born after short birth intervals. These associations between child-spacing and child mortality are now documented for such a large variety of societies in terms of birth interval patterns, health and contraceptive provision, and levels of human development that it is implausible to ascribe the observed association to problems of data quality or to interplays between health and contraception.

These findings thus constitute an important component of the "health rationale" for family planning. For the health of children it is birth-spacing that appears to be crucial, along with the avoidance of very early child-bearing. For the health of the mother, it is avoidance of repeated risks of pregnancy and birth (not having "too many") which is probably the most important element of the health rationale for family planning.

This study strongly reinforces the proposition that, at the societal level, family planning can indeed save the lives of children (through delaying child-bearing at least to age 18 and possibly to age 20, and more especially through achieving birth intervals of at least two years). These survival benefits can be quite considerable and are likely to be complemented by wider health benefits for the child. The health rationale for family planning is thus a strong one.

However, at the individual level, family planning programmes must be cautious about how the health rationale is conveyed, since there is always a risk that individual mothers who avoid "high risk" timing of their births do experience child or maternal death. Nevertheless, the potential health gains from family planning are considerable in many societies and these benefits need communicating to individual women and couples in an appropriate and sensitive way. An increased emphasis on use of contraception in order to alter the timing of births is thus warranted, including the postponement of first births to perhaps age 20 and achieving a spacing of at least two years between successive births.

A particularly sensitive problem occurs when the most recent child has just died. Evidence from this and other studies strongly suggests that a short interval to the next birth will increase the risk of death for the next child. Since a child death interrupts breastfeeding (and post-partum abstinence) the mother is at

an increased risk of pregnancy without the use of contraception; she may also wish to replace the dead child. This makes a two-year interval harder to advocate and achieve.

The situation in sub-Saharan Africa leaves room for concern. Clear evidence is emerging of a significant collapse of traditional post-partum taboos on resumption of intercourse following a birth in many African societies and considerable apprehension that prolonged breast-feeding patterns may also erode. These changes could lead to an increase in the proportions of births which occur after short intervals, thus raising the size of the risk group. There is a clear policy need to reinforce traditional breast-feeding patterns both for the health of the child being breast-fed and for the health of the next child. Nascent family planning programmes must also pay close attention to reinforcing traditional child-spacing mechanisms through appropriate education and contraceptive provision.

A second concern for sub-Saharan African countries must be whether the differentials in child survival by length of the preceding interval will widen, perhaps as a result of lower overall child mortality levels leaving more scope for the underlying disadvantages to show up. There are some indications to suggest that this widening of differentials is already occurring in Botswana and Zimbabwe.

There are clear indications from a number of the analyses presented in this report that the fraction of high risk births typically declines in societies where fertility decline is under way. Thus, family planning programmes (and delayed marriage) are contributing in a direct way to lowering child mortality, and this effect can be reinforced by improving the information, education and communication aspects of programmes concerning the timing (rather than the quantity) of births and by establishing supplies of methods which are relevant to spacing births.

Health policy consequences of the findings on excess risks associated with the timing of births and the clustering of deaths within families also need stressing. The comparisons contained in this report strongly suggest that the excess risks associated with poorly-spaced births have increased between the 1970s and the 1980s. It is therefore important that health programmes take account of these findings and try to reduce the risks associated with high risk births. Pregnancies that occur shortly after a previous birth can be identified, as can those where earlier births, especially the immediately preceding one, have died. These women and their children need priority for pre-natal, obstetric and post-natal care. Intervention would be simpler and could be focused if the underlying mechanisms causing the observed associations were known. Ensuring basic levels of nutrition for the mother and the child might well help. Careful evaluation of intervention programmes might also help to clarify the underlying pathways for the excess risks.

Health programmes should also encourage breast-feeding, not just for improving the survival and nutritional chances of the current child, but also to delay the next pregnancy and thus increase the survival chances of both the existing and the next child.

Family planning is one of the several possible "routes to improved child survival" identified in this report. Additional messages in other arenas come clearly from the various analyses. The potential gains from reducing or eliminating regional disparities within countries and from improving levels of maternal education are as large as those from improving the timing of births. Moreover, improvements over time, net of all the factors controlled in this study, are also typically large. The interplay of all of these factors with health interventions and their effectiveness is poorly studied. Informed programmatic choice requires even more detailed studies than those presented in this report. Moreover, although the observed associations are pervasive, programmes need to pay attention to the circumstances in individual societies. Patterns of association with region of residence, with level of mother's schooling, and with the timing of births have been shown to differ systematically by broad geographic or cultural regions. Informed and sensitive policy choices should identify and take account of these differences, rather than being prescriptive across all countries.

PART ONE

CHILD-SPACING AND CHILD MORTALITY

A. Background

Results from analysis of the World Fertility Survey (WFS) demonstrate a consistent and powerful association between fertility patterns, particularly short birth intervals and teenage child-bearing, and the chances of child survival (see, for major comparative analyses, Hobcraft, McDonald and Rutstein, 1983 and 1985; Palloni and Millman, 1986; and Hobcraft, 1987). These findings commanded wide attention and provided a sound basis for renewed emphasis on the health rationale for family planning which was highlighted by the Nairobi Conference on Better Health for Women and Children through Family Planning in 1987. This Conference brought together as co-sponsors an unprecedented range of international agencies: International Planned Parenthood Federation (IPPF), the Population Council, United Nations Children's Fund (UNICEF), United Nations Development Programme (UNDP), United Nations Population Fund (UNFPA), World Bank and World Health Organization (WHO).

The consistency and strength of the deleterious effects of a short preceding birth interval (and, to a lesser extent, of a short subsequent interval) on child survival came as a surprise to many scholars, although findings on this issue date back at least to the 1920s (for a discussion of this literature, see e.g., Hobcraft, McDonald and Rutstein, 1983; Hobcraft, 1987). Indeed, concern among clinicians, midwives, and the wider populace with the consequences of the timing and spacing of births for the life chances of the mother and the child has been widespread for hundreds of years and, quite probably, since time immemorial. Longstanding concerns with child-spacing, often achieved through extended periods of abstinence from sexual relations after a birth, are reflected in many societies. For example, McLaren (1984, p. 9) refers to an English study of 1652 which drew attention to the need to prolong breast-feeding in order to help child survival. The original meaning of *kwashiorkor*, a disease of a young child displaced from its mother's breast by a new baby, reflects strong popular concern with maintaining adequate child-spacing for health reasons in Ghana (Williams, 1953).

Superficial statistical evidence has long supported the popular belief that births occurring to young and old mothers, births at high parities, and births too close together are all at an increased risk of death. Yet, these bio-demographic characteristics of births interact with each other, as is often acknowledged—especially in the study of joint effects of combinations of mother's age and birth order (see, for useful reviews of this topic, Nortman, 1974; Omran, 1976, 1981). Until recently, though, very few studies that examined evidence for the effects of short birth intervals on life chances paid sufficient attention to possible associations with age of mother or parity. Equally, the likely consequences of birth-spacing patterns for associations of mother's age and order of the birth with child survival had rarely been formally considered, although both possibilities had long been recognized.

Bio-demographic attributes of births are also often associated with other attributes which alter the risk of survival of children, including poverty, educational and other deprivation, and access to health services. Teenage child-bearing and high fertility usually occur more frequently in deprived groups. A failure to control for socio-economic factors may distort inferences about risks associated with differing family formation patterns.

This need for careful controls has long been recognized. For example, Stevenson (1923), in his pioneering study based on the 1911 Census of England and Wales, examined associations between family size and proportions of children dead, controlling for duration of marriage and, in some analyses, both for the mother's and the father's ages at marriage; he also felt it necessary to control for occupation. In these respects his study was more careful than many done since then, and it is worthwhile to give a flavour of his conclusions:

> "Generally speaking, it appears that if the mean interval between births is less than two and a half to three years mortality is increased to such an extent that the loss implied more than counterbal-

ances the advantage of shorter exposure to risk." (p. li)

"It seems probable both that large families promote high mortality and that high mortality promotes large families; but the separate effects of these influences remain very difficult to measure." (p. lii)

"In view of this close relationship between the size of the family and the mortality of its members it will be seen that the recent decline in the mortality of early life must to a considerable extent be attributable to the reduction in size of the family, and must to that extent be discounted as an indication of sanitary progress." (p. lii)

"...when the effects of varying social status and size of the family have been as far as possible eliminated, the relation of child mortality to mother's marriage age is broadly one of simple increase of mortality with increase of age. To this rule there seems to be but one real exception - the relatively high mortality for young mothers in the first years of marriage." (p. lix)

These extended quotes from Stevenson serve to illustrate that many of the concerns expressed in the current literature are by no means new. He was clearly interested in policy impact as well as the statistical results and was sensitive to many methodological issues. Stevenson was blessed with an enormous sample (in fact, a complete census). This helped him to elaborate several analyses in purely tabular form, which typically require modern statistical methods with smaller samples. Understanding of the underlying processes involved and of potential methodological pitfalls has improved since then. So has the range of appropriate statistical techniques and the availability of more refined and targeted information.

The link between the timing of births in the maternal life-course and the subsequent survival chances of these births has been well established and extensively documented for a large number of countries in the developing world using data from WFS (for the major comparative analyses see Hobcraft, McDonald and Rutstein, 1983, 1985; Palloni and Millman, 1986; Hobcraft, 1987). These studies and many other single country studies (see National Research Council, 1989) have consistently demonstrated a powerful negative association for child survival chances if births occurred too early in the maternal life-course (teenage motherhood, especially births before age 18) or too soon after a preceding birth (usually taken as less than two years, with the association being particularly strong where the interval is less than 18 months). The results from WFS did not generally show significant disadvantages for child survival associated with higher parity births or with births to mothers aged 35 and over, although the design of the surveys is not ideal for addressing these issues.

The effects of short birth intervals on child survival persist (though they are sometimes attenuated, for example in the case of controls for sibling survival) in the face of all controls that have been tried, including the other bio-demographic correlates of child mortality (sex of child, age of mother at birth, birth order, sibling survival, and breast-feeding duration), the available socio-economic correlates (mother's and her husband's education level, husband's occupation, type of place of residence) and controls for unobserved clustering of deaths due to the family mortality environment.

In trying to unravel the mechanisms involved in causing an association between birth intervals and child survival - if it is indeed a causal one - analysts have tried to distinguish between sibling competition and maternal deprivation, but results have usually been inconclusive (e.g., Cleland and Sathar, 1984; Hobcraft, McDonald and Rutstein, 1983, 1985; and, for reviews of the evidence, Hobcraft, 1987; National Research Council, 1989). Evidence is often lacking on key variables which might help in understanding the mechanisms involved, including birthweight and gestational aspects (see Da Vanzo, Butz and Habicht, 1983; and Da Vanzo, Habicht and Butz, 1984, for some evidence on persistence of associations of child mortality with length of birth interval after controls for birthweight and previous obstetric history).

Since these findings have had a considerable policy impact, there is concern as to whether the association

between short birth intervals and child survival is indeed a causal one. The major studies which present results on the association are quite careful to point out and address, as far as data limitations permit, the problems which have subsequently been raised. Prematurity almost certainly serves to exaggerate the apparent excess mortality associated with very short preceding intervals. Miller (1989) suggests that this is an important explanation of the observed association for perinatal mortality in Hungary and Sweden, two countries with low overall child mortality and good compensatory health care, although quite strong differences still remained. (However, the other side of the coin, namely, the role of short birth intervals as one of the causes of prematurity is not usually addressed in studies examining this issue). Several earlier studies on developing countries had concluded that the impact of prematurity on the observed associations was quite small (Wolfers and Scrimshaw, 1975; Hobcraft, McDonald and Rutstein, 1985; Pebley and Stupp, 1987).

Data quality is an important concern in assessing results from retrospective event histories, such as WFS and DHS. Most of the major analyses addressed these issues and concluded that differential omission of dead children would lead to a downward bias in the observed associations. The most cogent critique of the main analyses on this count has come from Potter (1988b), who suggests combinations of reporting errors which might lead to spurious associations between child spacing and child mortality. However, a simulation study by Trussell (1987) addresses the issue of differential imputation of dates of birth for surviving and dead children and, in a complex regression model replicating the model used by Hobcraft, McDonald and Rutstein (1983), concludes that differential imputation makes little difference to the substantive interpretation of the estimated effects.

It has also been suggested that the effects are spurious due to the associations between child-spacing and access to and use of health care and links to contraceptive use (Potter, 1988b). Since contraception is an important proximate determinant of interval length and given the association of contraceptive use with other characteristics associated with child survival, including use of health-care facilities, the observed correlations of child survival with interval length may be spurious. However, since most contraceptive use in most of the WFS countries was for stopping rather than spacing purposes, it is true that the most important proximate determinant of the proportion going on to have the next birth is contraception. It is by no means self-evident that closed intervals for contraceptive failures are necessarily longer. In addition, findings on the association between short birth intervals and child survival are persistent across societies with widely differing health service provision. Lantz, Partin and Palloni (1992), in a study using data from WFS, cast doubt upon the validity of Potter's hypothesis, although the nature of the WFS data does not always permit conclusive analysis.

Child mortality is clustered within families and this can present problems of interpretation. The survival status of the preceding child is taken as a partial proxy variable for the family mortality environment by Hobcraft, McDonald and Rutstein (1985) who find that the deleterious effects of a short preceding interval are approximately the same, regardless of the survival status of the preceding child, once this is taken into account. Aaby (1988) reviews evidence that measles transmission and case fatality are associated with overcrowding and thus with a concentration of young children in the family. This suggests a possible mechanism associated with crowding, rather than short birth intervals *per se*. As yet, the empirical assessment of the consequences of clustering of child deaths for the observed associations between birth intervals and child survival is scant (though see Da Vanzo, Butz and Habicht, 1983, for an attempt to control for clustering of young children; and Curtis, McDonald and Diamond, 1993, for an illustrative analysis of the use of random-effects models to allow for the statistical biases that might be induced by ignoring clustering within families). This issue is discussed at much greater length in part two of this report.

Teenage child-bearing is also shown to be disadvantageous for child survival (e.g., Hobcraft, McDonald and Rutstein, 1985; and Hobcraft, 1987, who further refines the excess risk as being greater for children born to mothers aged under 18). These authors were

well aware of the possible limitations of inferring a direct bio-demographic causality, stressing in the 1985 conclusion "there are sound biological explanations, as well as the likely association of teenage pregnancy and socio-economic disadvantage in societies whose members marry later in life." In a study of the associations of teenage motherhood with child mortality for the United States, Geronimus (1987) argued that most of the excess mortality arose from socio-economic disadvantage, rather than being of biological origin. As a consequence, she questioned whether findings on excess mortality for teenage motherhood derive at all from biological factors in developing countries. However, the degree of social selection for disadvantage with early child-bearing is inevitably much greater in the United States (and other societies with normally delayed child-bearing) than in (at the other extreme) Bangladesh, where fully 88 per cent of all first births occurred to teenage mothers (Hobcraft, 1987).

There are also a number of questions concerning the potential policy implications of these findings. Possible gains in overall survival chances of up to 30 per cent from improved timing of births were first suggested by Trussell and Pebley (1984). This topic was further addressed in some detail by Hobcraft (1987), who also stressed that shifts to less favourable fertility patterns in sub-Saharan Africa could lead to increases in overall child mortality. Both of these studies were careful to stress that the possible gains in child mortality from improved child-bearing patterns were maximal estimates, on the assumption that all the observed associations were real.

Debate about this issue of possible gains in child mortality from improved family planning was focused by Bongaarts (1987), who suggested that likely changes in child mortality with fertility decline would be upwards, rather than downwards. Bongaarts assumed that the proportion of short birth intervals was likely to rise with increased fertility control, based on the predicate that all high fertility societies have long birth intervals (as in sub-Saharan Africa) and that all low fertility societies (typified by Latin America) have short birth intervals. This runs directly counter to Potter's assumption quoted earlier, and the changes in birth intervals within the countries observed using data from WFS and DHS do not support this assumption. His use of reliable data from Matlab Thana in Bangladesh, where birth intervals were already long enough to ensure that family planning could not provide gains from further lengthening of intervals (except, possibly, where the preceding child died) has also been criticized. Moreover, the assumed excess risk for first births that Bongaarts used was contrasted with especially advantaged later births and thus substantially overstated the risks of a first births compared with all other births. (For further discussion of these issues see Potter, 1988a; Trussell, 1988; Bongaarts, 1988; Hobcraft, 1990 and Palloni and Pinto, 1989).

For Latin American, Middle Eastern and Northern African countries for which relevant data are available, the high prevalence of short and very short birth intervals suggests that family planning policies targeted on improving birth-spacing might help to lower child mortality. For many sub-Saharan African countries, the proportion of short birth intervals is low, mainly from traditional fertility restraints; in these countries the potential of family planning for child-spacing might serve to prevent a rise in child mortality from otherwise changing patterns of child-bearing during the onset of their fertility transition. Hence, any policy lessons need to be drawn selectively, depending upon the societal content.

B. Data and methods

DHS provide a further opportunity to address the issues regarding the association between fertility patterns and child survival. The evidence from WFS typically covered experience from the 1960s and part of the 1970s. There have subsequently been major changes of emphasis in child survival programmes and, indeed, family planning programmes. There is thus a need for a more up-to-date assessment of the associations. It is probably still too early to assess whether a greater stress on child-spacing through contraception has had much impact on birth intervals or, consequentially, upon child survival. The data from DHS, which are considered here, typically span the 1970s and the 1980s (see table 1). Very

TABLE 1. DATA FROM DEMOGRAPHIC AND HEALTH SURVEYS IN 25 COUNTRIES AND WORLD FERTILITY SURVEY IN 8 COUNTRIES

Country	Survey year	Total births to mothers aged under 35	Total deaths of children of mothers aged under 35	Death rate by age 5 (per 1,000)	Period covered by DHS	Total fertility rates, 0-3 years before survey	Decline in partial total fertility rate for ages 15-34, 12-15 to 0-3 years before survey	WFS birth cohorts	Overlap (years)
Bolivia	1989	14 284	2 059	144	1974-1989	4.9	0.6		
Brazil	1986	8 874	877	99	1971-1986	3.6	0.9		
Colombia	1986	7 121	419	59	1971-1986	3.2	1.2	1960-1975	5
Dominican Republic	1986	11 439	1 016	89	1971-1986	3.7	1.6		
Ecuador	1987	7 721	751	97	1972-1987	4.1	1.5		
Guatemala	1987	11 444	1 432	125	1972-1987	5.5	0.7		
Mexico	1987	14 711	1 081	73	1972-1987	4.0	1.5		
Peru	1986	8 323	971	117	1971-1986	4.2	1.5	1961-1977	6
Trinidad and Tobago	1987	4 878	173	35	1972-1987	3.1	0.5	1961-1976	5
Egypt	1988	22 279	3 268	147	1973-1988	4.6	1.1		
Morocco	1987	15 310	1 946	127	1972-1987	4.6	1.8	1964-1979	8
Tunisia	1988	10 683	819	77	1973-1988	4.3	1.0		
Botswana	1988	7 969	489	61	1973-1988	4.8	1.2		
Burundi	1987	8 263	1 590	192	1972-1987	6.5	0.4		
Ghana	1988	8 846	1 357	153	1973-1988	6.1	0.6		
Kenya	1988/89	17 773	1 625	91	1973-1989	6.5	1.1	1962-1977	4
Liberia	1986	10 851	2 512	232	1971-1986	6.4	-0.2		
Mali	1987	8 210	2 421	295	1972-1987	6.8	0.1		
Senegal	1986	9 889	2 206	223	1971-1986	6.4	0.7	1962-1977	7
Togo	1988	6 931	1 109	160	1973-1988	6.2	0.9		
Uganda	1988/89	11 134	2 043	184	1973-1989	7.2	0.5		
Zimbabwe	1988	8 104	682	84	1973-1988	5.3	1.2		
Indonesia	1987	24 683	2 865	116	1972-1987	3.2	1.7		
Sri Lanka	1987	10 699	471	44	1972-1987	2.7	0.9	1959-1974	3
Thailand	1987	11 035	558	51	1972-1987	2.2	1.6	1959-1974	3
Total (25 DHS)		281 452	34 740						

Sources: Demographic and Health Surveys individual recode files and F. Arnold and A. K. Blanc, *Fertility Levels and Trends*, Demographic and Health Survey Comparative Studies, No. 2 (Columbia, Maryland, Institute for Resource Development/Macro Systems, September 1990), tables 4.1 and 4.3.

little information is available after the time of the Nairobi Conference on Better Health for Women and Children through Family Planning in 1987, and proper assessment of the impact in most countries will have to await studies during and covering the 1990s. Nevertheless, it is clearly desirable to examine more recent information, in order to assess whether there has been any change in the relative risks of child mortality associated with child-bearing patterns, and whether such patterns have changed for the better or worse, in terms of their likely impact on child mortality.

In this part of the report, straightforward tabular analyses are presented using the results from 25 DHS. The analyses replicate and extend the analysis presented by Hobcraft (1987) using WFS data for 18 countries. Table 1 shows details of the countries

covered, giving the dates of DHS. The analysis covers the experience of 15 complete years preceding the surveys plus the year(s) of fieldwork: these periods covered are shown in table 1. The results for these 25 countries encompass just over 280,000 births and nearly 35,000 deaths before age five. There is considerable variation in the sample sizes, with fewer than 5,000 births (and only 173 child deaths) in Trinidad and Tobago, and more than 20,000 births in Egypt and Indonesia (both with around 3,000 child deaths). Child mortality rates also vary considerably, being below 50 per 1,000 births in Trinidad and Tobago and in Sri Lanka, and nearly 300 per 1,000 for Mali.

Assessment of the potential past health role of family planning depends in part upon levels of fertility. Table 1 shows the estimated total fertility for the period 0-3 years before DHS, and an indication of the change in fertility levels (measured by the partial total fertility for women aged 15-34) over the 15 years considered here (see Arnold and Blanc, 1990). Total fertility is still very high in most of the sub-Saharan African countries (being below six children per woman only for Botswana and Zimbabwe) and is low in the three Asian countries; a very wide range of recent fertility levels is covered. Several countries show evidence of significant fertility decline within the 15-year period covered by the present analyses, with declines in the partial total fertility rate for women aged 15-34 in excess of one and a half births for Dominican Republic, Ecuador, Mexico, Peru, Morocco, Indonesia, and Thailand. In sub-Saharan Africa, Botswana, Kenya, and Zimbabwe (and perhaps Togo), all show significant declines of about one child per woman.

Eight of the countries covered in the earlier study (Hobcraft, 1987), based on WFS data, are also included in the present study, enabling direct comparisons of change over time to be made. The opportunities for change to appear are, however, limited by the considerable overlap between the periods covered by the analyses for WFS and DHS, as indicated in table 1.

Analysis is restricted to births occurring to women aged less than 35 years at the time of the birth, since the design of DHS typically excludes women who were older than 49 at the time of the surveys, and a 15-year period of observation means that more or less complete experience is included to women below age 35 for the whole period. Analyses which included births to women over 35 would generally understate mortality differentials for this group, as experience would be unduly concentrated towards the time of the survey, when mortality levels would usually be lower. Such trends could also distort analyses which did not disaggregate by age.

The results are presented in simple tabular form, without elaborate controls for potentially confounding variables. Earlier work from WFS provides some reassurance that the effects associated with young ages of child-bearing and with short birth intervals persist in the face of all controls that have so far been attempted, including those for socio-economic status, survival of the preceding child, sex and duration of breast-feeding (see Hobcraft, McDonald and Rutstein, 1983, 1985; Palloni and Millman, 1986; Bobadilla, Schlaepfer and Alagon, 1990). It will also be shown in part two of this report that control for a wide range of other variables does not remove these associations.

Life-tables have been calculated covering the mortality experience over 15 complete years plus the year of the survey. In total, the study uses information from DHS concerning the survival chances of about 280,000 children and some 35,000 deaths. In order to keep the amount of material manageable and to summarize overall patterns, in general only the chances of survival to age five will be presented, without further disaggregation by age of the child.

The first analysis examines the effects of maternal age on child survival for each of the 25 DHS and then provides a comparison with earlier WFS results. Secondly, the association of child mortality with length of the preceding birth interval is considered. This is followed by a digression to examine the robustness of the findings to date imputation. The results on age of mother and preceding birth interval are then brought together, using a 10-category classification of "family formation" pattern, which distinguishes different patterns of child-bearing. Finally, the possible gains in child survival from alterations in family formation patterns that have occurred over time and might be made in the future are addressed.

C. Age of mother

Table 2 shows the differences in child-bearing patterns and mortality risks by age of mother for the 25 DHS. The first panel provides the distribution of births. On average, across all 25 DHS (and for the 18 WFS covered by Hobcraft, 1987), just under 20 per cent of births to women under age 35 are to teenage mothers. Only a few countries lie outside the range of 15 to 25 per cent: Liberia (28), Uganda (28), Burundi (12), Sri Lanka (10) and Tunisia (7). In several sub-Saharan African countries (Liberia, Uganda, Mali and Senegal) 13 per cent or more of the births to women aged under 35 are to mothers under age 18, usually perceived as a high risk group.

Table 2 also provides the relative risks of death for children born to each age group of mother, with the overall rate for children born to women aged 20-34 being used as the reference category. The average across all 25 DHS countries indicates a 46 per cent excess mortality risk for children born to mothers aged under age 18. There is a smaller (16 per cent) average excess associated with the mother being an older teenager. The excess risk for younger teenage mothers is a little higher in Latin America and a little lower for the sub-Saharan African countries, although several of the latter group have apparently greater excess mortality risks for the children of older teenage mothers. These results agree with the average pattern for the 18 WFS countries, which are given as the last line in table 2. This agreement occurs despite the two groups of countries having only eight in common and both groups being an arbitrary selection.

The risks attributable to population are also given for each country in the last column of table 2. The population attributable risk is simply a calculation of how much excess mortality is observed in each country as a consequence of the combined impact of the observed excess risks and the child-bearing patterns. It is identical to the ratio of the overall death rate by age five for all children included here (mothers under age 35) to the death rate for the baseline group (restricted to mothers aged 20-34 at the time of the birth). It is thus an estimate of the mortality that might be avoided if all births occurred to mothers in the 20-34 age range and all the excess mortality for teenage mothers was simply due to their being teenagers and not a consequence of other characteristics selectively associated with teenage motherhood. As always, this means that the potential gains from delaying child-bearing are almost certainly overstated by this analysis. Clearly, the potential for population level reductions in child mortality from delaying child-bearing to at least age 18 and perhaps to age 20 is not large. This is not surprising, since (usually well) over 70 per cent of all births are in the reference group for all 25 countries considered. Although the excess risks are substantial, the proportions of births experiencing the excess risk are not large. The potential maximal gains range from 1 to 12 per cent.

The survival of the first-born child is of considerable importance in its own right and a much greater fraction of first births occur to teenage mothers. The final panel of table 2 is restricted to first births. Across all 25 DHS, about half of all first births are to teenage mothers. This fraction is below a quarter for Tunisia and Sri Lanka, and as high as three quarters for Uganda. The excess risk of child mortality associated with early first births averages 43 per cent across all 25 countries (some of this excess would be reduced with controls for socio-economic status, as shown in part two). The population attributable risks for first births are also much higher, only being below 110 (or a 10 per cent excess) for Tunisia and Sri Lanka, and surpassing 140 (a 40 per cent excess) for Mexico and Peru. These results suggest that successful programmes aimed at enabling women to delay their first birth might significantly improve the chances of survival for first-born children in many countries, in addition to the many advantages accruing to the women themselves from delaying entry into motherhood. At the overall population level, improving the survival chances of first births through delay, would have a larger total impact with declining fertility levels, since the fraction of first births among all births is thereby increased.

TABLE 2. CHILD-BEARING PATTERNS AND MORTALITY RISKS FOR 25 DEMOGRAPHIC AND HEALTH SURVEYS COUNTRIES, BY AGE OF MOTHER

Country	Births, by age of mother (per 1,000)					Relative risk (20-34 = 100)					Mortality rate q(5) for births to mothers aged 20-34	Population attributable risk	First births only, by age of mother				
													Births		Relative risk		
	Under 18	18-19	20-24	25-29	30-34	Under 18	18-19	20-24	25-29	30-34			Under 20	20-34	Under 20	20-34	Population attributable risk
Bolivia	71	100	323	295	212	117	109	106	98	94	141	102	461	539	135	100	116
Brazil	66	95	358	312	169	167	122	102	102	91	93	107	355	645	181	100	129
Colombia	84	115	364	272	165	162	105	96	88	130	56	106	433	567	166	100	129
Dominican Republic	106	127	348	262	157	161	100	99	99	104	83	106	538	462	169	100	137
Ecuador	79	117	353	276	175	141	94	106	101	87	95	103	484	516	129	100	114
Guatemala	97	122	343	280	158	152	130	101	106	87	115	109	588	412	139	100	123
Mexico	92	115	344	274	175	119	123	98	103	99	70	104	493	507	197	100	148
Peru	66	100	325	300	208	158	102	99	95	109	112	104	446	554	192	100	141
Trinidad and Tobago	75	125	376	274	148	210	131	109	98	81	32	112	417	583	138	100	116
Egypt	76	96	334	304	191	179	131	108	95	94	135	109	435	565	183	100	136
Morocco	57	90	337	306	211	163	127	102	101	95	120	106	435	565	148	100	121
Tunisia	12	56	339	351	242	205	102	102	103	92	76	101	224	776	122	100	105
Botswana	107	141	344	251	158	116	91	103	100	95	61	100	646	354	122	100	114
Burundi	33	83	347	322	216	108	126	103	102	92	188	102	369	631	128	100	111
Ghana	89	108	334	279	190	151	105	104	98	96	146	105	567	433	125	100	114
Kenya	107	121	331	265	177	146	119	111	92	91	85	107	689	311	121	100	115
Liberia	154	127	327	242	150	138	121	110	92	91	213	109	658	342	142	100	128
Mali	129	113	306	265	187	130	129	103	97	99	275	107	656	344	128	100	119
Senegal	129	117	326	253	175	125	104	102	97	101	215	104	676	324	119	100	113
Togo	106	114	329	268	183	107	139	102	105	90	152	105	637	363	118	100	112
Uganda	145	131	328	241	154	140	116	100	105	91	170	108	751	249	138	100	128
Zimbabwe	94	119	340	269	178	135	126	106	91	102	79	106	600	400	130	100	118
Indonesia	95	119	347	264	176	150	118	102	98	99	109	107	543	457	138	100	121
Sri Lanka	30	71	331	343	225	158	96	96	110	90	43	101	231	769	118	100	104
Thailand	53	105	361	300	180	113	132	98	96	110	49	104	354	646	142	100	115
Mean 25 DHS	86	109	340	283	182	146	116	103	99	96		105	507	493	143	100	121
Mean 18 WFS	91	104	324	284	197	141	112	99	97	105		105	527	473	139	100	121

Sources: Demographic and Health Surveys individual recode files and John Hobcraft, "Does family planning save children's lives?", Technical paper for the International Conference on Better Health for Women and Children through Family Planning, Nairobi, 5-9 October 1987.

NOTE: 15 years before DHS.

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Results for the eight countries with information available from both WFS and DHS are provided in table 3. The proportion of births to teenage mothers has remained remarkably constant over time for the first five countries (Colombia, Peru, Trinidad and Tobago, Kenya and Senegal). There has been a significant reduction in the fraction of births to teenage mothers in Morocco and Sri Lanka, and a significant rise in Thailand, perhaps as a consequence of reduced fertility at older ages. The excess risk of child death associated with births to younger teenage mothers appears to have increased over time, except for Sri Lanka where the excess risk was already high and the numbers of births to such mothers is anyway low. The excess risk for children of very young mothers in Thailand is strikingly low in both WFS and DHS; it is also low for Senegal. With the exception of Trinidad and Tobago, where sample sizes in both surveys are small, the population attributable risks do not alter much over time. The potential gains from delaying motherhood are not yet being realized in these eight countries, since there is generally little change between the two surveys.

TABLE 3. COMPARISON OF DATA FROM WORLD FERTILITY SURVEY AND DEMOGRAPHIC AND HEALTH SURVEYS ON CHILD-BEARING PATTERNS AND MORTALITY RISKS IN EIGHT COUNTRIES, BY AGE OF MOTHER

Country	Births, by age of mother (per 1,000)					Relative risk (20-34 = 100)					Mortality rate q(5) for births to mothers aged 20-34	Population attributable risk
	Under 18	18-19	20-24	25-29	30-34	Under 18	18-19	20-24	25-29	30-34		
Colombia												
WFS	82	111	334	279	194	127	125	100	100	101	96	105
DHS	84	115	364	272	165	162	105	96	88	130	56	106
Peru												
WFS	68	90	317	294	231	115	104	96	100	106	158	101
DHS	66	100	325	300	208	158	102	99	95	109	112	104
Trinidad and Tobago												
WFS	78	112	361	278	171	152	80	98	89	122	46	102
DHS	75	125	376	274	148	210	131	109	98	81	32	112
Morocco												
WFS	90	100	320	287	203	146	122	104	96	99	142	106
DHS	57	90	337	306	211	163	127	102	101	95	120	106
Kenya												
WFS	116	117	324	259	184	142	117	96	101	105	137	107
DHS	107	121	331	265	177	146	119	111	92	91	85	107
Senegal												
WFS	127	121	302	261	189	116	105	102	100	96	256	102
DHS	129	117	326	253	175	125	104	102	97	101	215	104
Sri Lanka												
WFS	58	83	309	319	231	164	109	100	104	96	75	105
DHS	30	71	331	343	225	158	96	96	110	90	43	101
Thailand												
WFS	44	83	325	310	238	103	123	98	96	107	105	102
DHS	53	105	361	300	180	113	132	98	96	110	49	104
Mean												
WFS	83	102	324	286	205	133	111	99	98	104	127	104
DHS	75	106	344	289	186	154	115	102	97	101	89	106

Sources: Demographic and Health Surveys and World Fertility Survey individual recode files.
NOTE: 15 years before DHS.

D. Length of preceding birth interval

Survival chances to age five by length of the preceding birth interval are given in table 4 for later births (order two and above). The average risk of child death, compared with an interval of 24-47 months, is about doubled for children born after very short intervals (1-17 months, where prematurity may contribute to the excess risk). There is around a 30 per cent excess risk for children born 18-23 months after the preceding birth. The agreement with the average relative risk patterns across the 18 WFS countries in the earlier study is remarkable, as shown by comparison of the last two rows of table 4. Nevertheless, there is considerable variability in these excess risks, which are relatively low in a number of sub-Saharan African countries (Senegal, Ghana, Liberia, and Togo), and especially high in Egypt, Botswana, Tunisia, Guatemala, and Brazil. There is no strong association of the levels of excess risk with the overall level of child mortality.

The low relative risks for longer preceding intervals (of four years or more) occurred consistently for WFS too, and are at least partially attributable to the impact of likely omissions of dead children, which would also lead to a downward bias of relative risks for short intervals. An alternative interpretation of the low risks associated with long intervals is Potter's (1988b) suggestion that longer intervals are associated with higher use of contraception and that access to and use of health services is related to access to contraception, especially where maternal and child health services are fully integrated.

Excess risks of death are atypically low for children born after very short birth intervals in Burundi, Ghana, Liberia, Senegal, Togo and Uganda. These countries are also predominantly the ones where the fraction of such births is very low. It is plausible that underreporting of deaths at very short intervals occurred for these countries, leading to a downward bias in the observed excess mortality. Imprecision in dating of births and ages at death is a prevalent feature in these countries (although this is less true for Uganda). With the exception of Mali (where there appear to be severe data quality problems), the countries with low excess risk of death for children born after very short intervals are those with the highest overall levels of child mortality before age five (with more than 15 per cent of children dying; see table 1). The relatively small excess risks may perhaps be genuine, reflecting the fact that differentials emerge most strongly at moderate levels of overall child mortality. The countries with a relatively small excess risk for births at very short intervals are also predominantly those with high fertility levels and quite prolonged breast-feeding, perhaps suggesting that a heavy nutritional load on mothers also depletes those with longer intervals more than in other societies, and this may further interact with the typically poor health environment. Furthermore, the absolute (as opposed to relative) excess mortality associated with very short birth intervals is still considerable, typically being at least as great as in the lower mortality countries with higher relative risks.

The distribution of births (of order two and above to mothers aged less than 35 years) across the categories of length of preceding birth interval is also shown in table 4. The average distribution for DHS shows about 35 per cent of birth intervals as being shorter than two years. This contrasts with the average for 18 WFS of 42 per cent. The detailed comparisons given later show that this difference is not simply an artifact of the different sets of countries included, but sometimes represents a genuine improvement in the pattern of birth interval distributions over time. The average across 25 DHS hides a great deal of variation among countries. Fewer than 30 per cent of births are poorly spaced (in the sense of being at intervals of less than two years after the previous birth) in Botswana, Togo, Ghana, Zimbabwe, Senegal, and Burundi, all of which are sub-Saharan African countries. More than 40 per cent of births are poorly spaced in Brazil, Dominican Republic, Colombia, Mexico, Trinidad and Tobago, Ecuador, Peru, Egypt, and Tunisia; this list comprises all but two of the countries in the Americas (Bolivia and Guatemala) and two of the three Northern African countries (the exception being Morocco). This combination of high excess mortality risks and poor child spacing patterns in the countries of the

TABLE 4. SURVIVAL CHANCES TO AGE 5 AND BIRTH DISTRIBUTION FOR 25 COUNTRIES, BY LENGTH OF PRECEDING INTERVAL

Country	Death rate, by months of interval					Relative risk, by months of interval					Birth distribution, by months of interval					Population attributable risk
	1-17	18-23	24-47	48-71	72+	1-17	18-23	24-47	48-71	72+	1-17	18-23	24-47	48-71	72+	
	(per 1,000)							(base)					(per 1,000)			
Bolivia	263	182	123	86	65	214	148	100	70	53	182	182	470	103	63	123
Brazil	185	105	72	69	38	259	146	100	96	53	295	179	363	97	66	151
Colombia	102	68	51	33	25	200	132	100	64	48	231	198	375	121	75	121
Dominican Republic	143	88	73	55	90	195	120	100	75	123	262	186	400	93	58	128
Ecuador	178	94	82	50	46	218	114	100	61	56	234	178	417	108	64	123
Guatemala	246	135	93	59	80	264	144	100	63	86	172	190	509	93	37	133
Mexico	129	86	66	49	42	195	130	100	74	63	221	198	414	102	66	122
Peru	201	148	103	63	30	195	144	100	61	29	216	191	444	92	57	121
Trinidad and Tobago	60	29	28	36	24	216	105	100	128	85	238	181	341	127	112	130
Egypt	299	163	96	55	65	313	170	100	57	68	238	169	432	108	52	156
Morocco	220	127	102	53	56	216	125	100	52	55	182	190	513	81	34	120
Tunisia	154	83	55	34	34	278	150	100	62	62	216	188	471	90	34	143
Botswana	164	75	57	38	46	288	131	100	66	82	70	126	592	149	63	111
Burundi	297	223	176	99	80	168	127	100	56	45	103	177	605	89	27	106
Ghana	210	187	145	120	107	144	129	100	83	74	89	136	594	133	47	104
Kenya	156	97	80	51	36	195	122	100	64	45	141	197	537	89	36	113
Liberia	311	262	207	140	88	150	126	100	67	42	170	189	487	103	51	107
Mali	469	320	235	143	133	200	136	100	61	57	196	177	486	96	45	120
Senegal	287	240	212	141	150	135	113	100	66	71	90	174	636	75	24	102
Togo	227	165	146	134	141	155	113	100	92	96	84	134	624	120	40	105
Uganda	255	215	149	126	94	172	145	100	85	63	131	212	555	75	27	117
Zimbabwe	170	106	71	52	64	238	149	100	72	90	90	154	603	112	41	116
Indonesia	199	132	105	71	75	188	125	100	67	71	142	162	502	127	67	111
Sri Lanka	76	50	38	36	46	198	131	100	92	121	132	174	492	129	73	119
Thailand	117	51	46	38	44	253	112	100	82	96	147	162	455	144	92	121
Mean 25 DHS						210	131	100	73	69	171	176	493	106	54	120
Mean 18 WFS						199	131	100	73	83	217	205	478	72	28	125

Sources: Demographic and Health Surveys and World Fertility Survey individual recode files and John Hobcraft, "Does family planning save children's lives?", Technical paper for the International Conference on Better Health for Women and Children through Family Planning, Nairobi, 5-9 October 1987.

NOTE: 15 years before DHS.

Americas and of the Arab countries (Northern Africa and Western Asia) was also found in earlier studies based upon WFS data (Hobcraft, McDonald and Rutstein, 1985; Hobcraft, 1987).

The combined impact of the distribution of birth intervals with the observed excess mortality risks is again summarized using population attributable risks. In this instance, the mortality for children born two or three years after the preceding birth is taken as the reference group and the overall excess mortality is assessed relative to the level for this group. The high relative risks and high proportions at risk both in Brazil and in Egypt lead to population attributable risks in excess of 150, suggesting considerable potential for improving child mortality for second and later order births in these countries. The excess is also well above 40 per cent for Tunisia. At the other extreme, the scope for improving child mortality levels through altering spacing patterns is very low indeed for several, if not most, of the sub-Saharan African countries included in the analysis. For these countries, the spacing pattern is already generally quite good, but could worsen with the erosion of traditional post-partum restraints on fertility. Moreover, it is at least possible that the relative excess risks associated with poor spacing might increase as mortality declines. Nevertheless, there is little to suggest that family planning would help to save children's lives by improving spacing patterns in these countries; such programmes could avert relative worsening of child mortality by maintaining already long birth intervals.

Improved child-spacing has the apparent potential to reduce child mortality, especially in the Americas and Northern Africa. There is a debate concerning the underlying mechanisms for the excess mortality associated with short preceding intervals (see Hobcraft, 1987; Potter, 1988b; National Research Council, 1989; Miller, 1989, 1991; Lantz, Partin and Palloni, 1992). Table 5 helps address these issues by providing a more detailed breakdown of child mortality risks according to the age of the child. Three age groups are considered: neonatal (the first month of life), post-neonatal (one to twelve months), and child (one to four years); these groups each encompass about one third of deaths under age five for most countries considered here (not shown), although child mortality is a larger component in a few sub-Saharan African countries. Some caution is required concerning divisions by age at death, since there is evidence to suggest heaping of reported ages at deaths at 12 months, some of which may in fact be infant deaths (see Sullivan, Bicego and Rutstein, 1990). For each of the age groups, the relative risk of death is shown, with the risk for intervals of 24-47 months set to be 100.

The average excess risks across all 25 countries associated with very short preceding birth intervals attenuate somewhat with increasing age of the child, particularly beyond the first birthday. This could be a result of increased incidence of prematurity among those born at short intervals (see Miller, 1989, 1991) or a consequence of maternal depletion, acting perhaps through birthweight. For births occurring 18-23 months after the previous child, the average relative risks barely change with age, although the value for child mortality is a little lower than either of the other values. For abnormally long intervals between births (six or more years), the average risk is quite low beyond, but not including the first month of life (it is also noted that the country-specific relative risks for these long intervals are highly variable as a result of small samples). It is clear that considerable caution should be exercised in assessing differentials for individual countries. For very short intervals, Colombia appears to have increasing relative risks with age of the child; for Egypt the relative risks are consistently very high; several countries exhibit quite sharp attenuation in the relative risks for this group with increasing age of the child. Further clarification of these variegated patterns of risk, including assessment of the role of statistical fluctuations, can only be done with more detailed regression analysis.

Experience from WFS and DHS for eight countries is summarized in table 6. Although there is some evidence of changes in the pattern of relative risks over time, the most striking changes occur in the distribution of births by length of previous interval. The fraction of short intervals (less than 24 months) reduces by 7 to 9 percentage points in Peru, Kenya, Morocco, Sri Lanka and Thailand, and by 13 and 15 percentage points respectively in Trinidad and Tobago and Colombia. The child-

TABLE 5. RELATIVE MORTALITY RISKS, BY LENGTH OF PRECEDING BIRTH INTERVAL AND BY AGE OF THE CHILD
(24-47 = 100)

Country	Relative risk, by months of preceding interval															
	1-17				18-23				48-71				72+			
	Neo-natal	Post-neonatal	Child	Under-5	Neo-natal	Post-neonatal	Child	Under-5	Neo-natal	Post-neonatal	Child	Under-5	Neo-natal	Post-neonatal	Child	Under-5
Bolivia	228	255	194	214	127	167	154	148	60	61	81	70	59	47	51	53
Brazil	216	324	208	259	125	170	135	146	132	77	74	96	65	58	16	53
Colombia	173	200	253	200	91	123	212	132	79	64	37	64	102	25	0	48
Dominican Republic	213	202	177	195	100	118	146	120	82	41	101	75	142	71	159	123
Ecuador	219	249	203	218	80	133	142	114	53	76	56	61	89	65	6	56
Guatemala	394	267	218	264	176	145	131	144	77	86	38	63	194	48	56	86
Mexico	220	210	149	195	153	111	127	130	99	50	74	74	119	22	44	63
Peru	277	188	165	195	170	136	141	144	67	53	65	61	49	24	22	29
Trinidad and Tobago	241	230	120	216	99	145	64	105	169	60	100	128	136	34	0	85
Egypt	354	330	316	313	169	180	170	170	70	53	50	57	72	73	59	68
Morocco	294	254	216	216	143	144	125	125	48	52	52	52	87	34	55	55
Tunisia	341	410	155	278	114	221	133	150	54	75	59	62	124	41	29	62
Botswana	320	343	237	288	181	137	86	131	76	93	36	66	131	53	63	82
Burundi	329	185	136	168	172	140	114	127	67	35	60	56	9	41	53	45
Ghana	219	190	98	144	144	150	117	129	59	91	89	83	160	72	34	74
Kenya	221	217	170	195	86	140	127	122	93	57	53	64	69	45	30	45
Liberia	202	182	101	150	137	148	106	126	64	63	69	67	37	36	47	42
Mali	394	212	175	200	145	149	135	136	74	44	60	61	63	68	50	57
Senegal	251	186	100	135	137	124	106	113	66	63	65	66	68	73	69	71
Togo	187	248	108	155	139	121	101	113	94	45	110	92	163	45	95	96
Uganda	283	206	121	172	124	171	145	145	99	69	87	85	95	81	40	63
Zimbabwe	276	236	226	238	157	99	186	149	96	33	85	72	139	62	72	90
Indonesia	256	227	132	188	143	139	107	125	84	70	54	67	74	82	60	71
Sri Lanka	246	222	126	198	143	144	108	131	100	65	108	92	148	171	44	121
Thailand	290	220	246	253	153	64	104	112	76	84	89	82	72	100	139	96
Mean 25 DHS	266	240	174	210	136	141	129	131	82	62	70	73	99	59	52	69

Sources: Demographic and Health Surveys individual recode files.

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TABLE 6. COMPARISON OF DATA FROM WORLD FERTILITY SURVEY AND DEMOGRAPHIC AND HEALTH SURVEYS ON SURVIVAL CHANCES TO AGE 5 AND BIRTH DISTRIBUTION IN EIGHT COUNTRIES, BY LENGTH OF PRECEDING BIRTH INTERVAL

Country	Deaths, by months of interval					Relative risk, by months of interval					Birth distribution, by months of interval					Population attributable risk
	1-17	18-23	24-47	48-71	72+	1-17	18-23	24-47	48-71	72+	1-17	18-23	24-47	48-71	72+	
	(per 1,000)							(base)			(per 1,000)					
Colombia																
WFS	141	111	79	53	80	179	140	100	67	101	347	232	337	60	24	135
DHS	102	68	51	33	25	200	132	100	64	48	231	198	375	121	75	121
Peru																
WFS	243	185	138	72	92	176	134	100	52	67	265	214	422	69	29	123
DHS	201	148	103	63	30	195	144	100	61	29	216	191	444	92	57	121
Trinidad and Tobago																
WFS	71	46	32	24	56	222	143	100	75	175	329	219	332	78	42	151
DHS	60	29	28	36	24	216	105	100	128	85	238	181	341	127	112	130
Morocco																
WFS	249	165	110	73	40	227	150	100	66	36	235	216	462	62	25	137
DHS	220	127	102	53	56	216	125	100	52	55	182	190	513	81	34	120
Kenya																
WFS	224	151	119	84	80	188	127	100	71	67	194	234	492	60	21	121
DHS	156	97	80	51	36	195	122	100	64	45	141	197	537	89	36	113
Senegal																
WFS	356	224	269	252	188	133	83	100	94	70	66	155	686	68	25	99
DHS	287	240	212	141	150	135	113	100	66	71	90	174	636	75	24	102
Sri Lanka																
WFS	112	80	72	59	54	155	111	100	82	75	179	207	487	91	35	109
DHS	76	50	38	36	46	198	131	100	92	121	132	174	492	129	73	119
Thailand																
WFS	196	107	85	49	118	231	125	100	58	139	205	195	509	68	23	130
DHS	117	51	46	38	44	253	112	100	82	96	147	162	455	144	92	121
Mean																
WFS	199	133	113	83	88	189	127	100	71	91	228	209	466	70	28	124
DHS	152	101	82	56	51	201	123	100	76	69	172	183	474	107	63	117

Sources: Demographic and Health Surveys individual recode files and John Hobcraft, "Does family planning save children's lives?", Technical paper for the International Conference on Better Health for Women and Children through Family Planning, Nairobi, 5-9 October 1987.

NOTE: 15 years before DHS.

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spacing pattern worsens in Senegal, with an increase of 4 percentage points in the proportion of poorly spaced births. The population attributable risk for Colombia suggests a significant 12 per cent reduction in overall child mortality for later births, primarily as a result of improved spacing patterns. The gain for Trinidad and Tobago is even larger, being about 16 per cent, though an improvement in the relative risk for births at intervals of 18-23 months contributes to this. There are also significant gains in the population attributable risk for Morocco (14 per cent), Thailand and Kenya (both 7 per cent). A worsening of the relative risks for Sri Lanka negates the improvements in child-spacing, and the population attributable risk increases over time (by 9 per cent) as a consequence. The worsening of the child-spacing pattern in Senegal is not sufficient to make a major difference to the population attributable risk. These quite substantial changes in child-spacing patterns over a short period (typically about 10 years), especially with a significant overlap in period covered between the successive surveys, do strongly suggest that the assumption about possible worsening of these patterns with fertility decline (e.g., Bongaarts, 1987) are not tenable. On the contrary, significant improvements in child-spacing patterns are occurring and child mortality is probably being modestly reduced as a consequence.

More detailed distributions of the births by length of preceding interval are presented in table 7 and the corresponding relative risks are shown in table 8. Perhaps the most striking finding from these tables is the remarkable extent of agreement between the average relative risks for WFS and DHS, for two arbitrary selections of countries with some overlap. The more recent information confirms that the risk of death before age five progressively worsens with shorter intervals.

TABLE 7. DISTRIBUTION OF BIRTHS BY LENGTH OF PRECEDING BIRTH INTERVAL
(Per thousand)

Country	Total births	Preceding interval (months)									
		Under 12	12-14	15-17	18-20	21-23	24-35	36-47	48-59	60-71	72+
Bolivia	12 652	50	63	69	80	102	325	145	65	38	63
Brazil	6 699	59	120	116	96	83	238	124	60	37	66
Colombia	5 589	39	91	101	101	97	251	124	78	42	75
Dominican Republic	9 325	61	108	93	92	95	273	127	62	31	58
Ecuador	6 450	68	88	78	87	92	289	128	71	37	64
Guatemala	9 553	40	63	68	84	105	364	145	63	30	37
Mexico	12 349	47	86	87	93	105	286	127	66	36	66
Peru	7 419	52	82	82	92	99	306	138	60	32	57
Trinidad and Tobago	3 609	36	102	100	94	87	215	126	80	47	112
Egypt	19 401	68	87	83	78	91	289	143	73	36	52
Morocco	14 428	48	72	63	78	112	374	139	54	27	34
Tunisia	9 497	48	90	77	81	107	334	137	61	30	34
Botswana	6 397	15	22	33	47	79	380	211	94	55	63
Burundi	7 556	24	37	42	55	122	419	186	65	24	27
Ghana	7 899	17	32	40	56	80	367	227	93	40	47
Kenya	16 235	37	51	53	79	118	389	148	63	26	36
Liberia	9 173	32	65	74	82	106	344	143	66	37	51
Mali	7 613	70	58	67	83	94	327	159	66	30	45
Senegal	8 745	19	29	41	54	120	459	177	51	24	24
Togo	6 219	21	26	36	54	80	388	236	82	37	40
Uganda	9 834	24	48	58	86	126	414	141	53	23	27
Zimbabwe	7 039	21	32	37	62	92	421	182	74	38	41
Indonesia	20 573	34	52	56	72	90	328	173	83	45	67
Sri Lanka	8 234	18	51	64	81	93	326	167	84	45	73
Thailand	8 170	33	54	59	77	84	292	163	90	54	92

Source: Demographic and Health Surveys individual recode files.
NOTE: 15 years before DHS.

TABLE 8. RELATIVE RISK OF DEATH BY AGE 5, BY LENGTH OF PRECEDING BIRTH INTERVAL
(24-47 = 100)

Country	Rate after 24-47 month interval	Relative risk, by months of interval									
		Under 12	12-14	15-17	18-20	21-23	24-35	36-47	48-59	60-71	72+
Bolivia	123	285	205	169	160	138	110	78	64	79	53
Brazil	72	420	233	202	145	148	114	71	101	87	53
Colombia	51	307	210	149	137	128	105	89	73	47	48
Dominican Republic	73	291	189	135	142	98	98	104	78	67	123
Ecuador	82	295	215	153	128	102	107	83	69	46	56
Guatemala	93	359	273	198	140	148	111	73	50	92	86
Mexico	66	243	214	151	127	133	110	77	82	60	63
Peru	103	258	188	162	149	139	111	75	70	45	29
Trinidad and Tobago	28	484	245	89	118	91	102	97	88	194	85
Egypt	96	384	313	253	180	162	117	64	61	48	68
Morocco	102	288	212	165	138	115	105	87	60	35	55
Tunisia	55	462	247	197	168	137	104	90	67	53	62
Botswana	57	348	220	304	174	105	106	89	71	58	82
Burundi	176	198	163	157	160	112	106	87	61	43	45
Ghana	145	185	130	137	155	114	97	105	87	72	74
Kenya	80	214	179	199	146	105	109	76	72	44	45
Liberia	207	161	155	141	141	115	109	76	77	50	42
Mali	235	230	197	170	138	134	104	91	63	57	57
Senegal	212	129	137	137	123	108	104	89	72	53	71
Togo	146	176	123	166	98	123	99	102	100	71	96
Uganda	149	215	159	165	166	130	104	87	78	101	63
Zimbabwe	71	349	184	224	113	173	105	88	72	73	90
Indonesia	105	236	190	158	115	133	109	83	66	69	71
Sri Lanka	38	404	178	153	103	155	109	82	105	69	121
Thailand	46	443	210	187	124	100	101	98	81	83	96
Mean 25 DHS		294	199	173	139	126	106	86	75	68	69
Mean 18 WFS		295	193	166	141	121	104	90	73		83

Sources: Demographic and Health Surveys and World Fertility Survey individual recode files and John Hobcraft, "Does family planning save children's lives?", Technical paper for the International Conference on Better Health for Women and Children through Family Planning, Nairobi, 5-9 October 1987.

NOTE: 15 years before DHS.

E. THE IMPACT OF DATE IMPUTATION

A recurring concern when using retrospective event history data is the problem of the quality of date reporting. It is often supposed that dates of birth for dead children are less reliably reported than are dates for surviving children. The recode files produced for DHS have a major advantage in this respect over those produced for WFS, because some of the uncertainty for imputed dates can be recovered. For each recorded date of birth of a child, an indicator variable shows how the date was reported (e.g., year and month, year only, age only, year and age, season and year, or no information). From this information on the nature of the report and the imputed date of the event, it is possible to recover the range within which imputation took place, where the month and year were not both reported. For each birth included in the present analysis a minimum and maximum date has been derived from this information. Given

these estimates, the maximum and minimum possible interval between each pair of births can be calculated. If the maximum possible interval is less than 24 months, the interval is treated as being "firmly" assigned to a short interval; if the minimum possible inter-birth interval equals or exceeds 24 months, the interval is taken to be "firmly" assigned to a long interval; for all remaining intervals, the possible range spans a 24-month threshold and these intervals are referred to as being "fuzzily" or imprecisely dated.

Basic information on the extent of imprecisely determined intervals is shown in table 9. The proportions of births per 1,000 where the assignment to long or short intervals is imprecise is quite small for many of the countries considered here. Moreover, the imprecise intervals are usually concentrated among the two categories close to the critical 24-month boundary. For example, in Morocco, 12.8 per cent of birth intervals assigned to the category 18-23 months on the basis of the imputed dates are actually of uncertain status with regard to a 24-month boundary when the imputation ranges are taken into account. Similarly, 10.8 per cent of the birth intervals assigned to the category 24-47 months in Morocco on the basis of the imputed dates could be shorter than two years. But much lower proportions of births assigned to the intervals which are not adjacent to the two-year threshold are doubtfully assigned to short or long intervals. Thus, in Morocco, 98.4 per cent of births assigned to preceding birth intervals of 1-17 months are almost certainly short intervals, in the sense that their range of possible dates does not permit the interval to be longer than two years.

Of all assigned interval lengths in Mali, 42 per cent are of uncertain or imprecise classification with respect to the 24-month divide. The imputation procedures used for Mali were atypical and extensive (see Sullivan, Bicego and Rutstein, 1990).

The simple categorization of preceding birth intervals into short and long intervals (a division at two years) is imprecise for several other countries, with about 23 per cent being imprecise for Togo, 13 per cent for Egypt, 12 per cent for Ghana and Senegal, 10 per cent for Burundi, 8 per cent for Morocco and Indonesia, 7 per cent for Liberia, and 6 per cent for Thailand; overall levels of imprecision were much lower elsewhere, at 4 per cent or less. Over 20 per cent of births classified as being at intervals of 18-23 months, according to the imputed dates, might be longer than two years in Mali, Togo, Egypt, Ghana, Senegal, Burundi and Indonesia, when the imputation ranges are taken into account. This proportion also exceeds 10 per cent in Liberia and Morocco. For a handful of countries, significant percentages of births recorded as being less than 18 months after the preceding birth, on the basis of imputed dates, are of uncertain status with respect to being definitively shorter than two years: Mali (45 per cent), Togo (33), Ghana (20), Thailand (11) and Senegal (8). Significant fractions of the preceding birth intervals which would normally be assigned to the 24-47 month (reference) category might conversely be below the two-year threshold; Mali is again the extreme case (40 per cent), followed by Togo (19) and Egypt (14); the percentage ranges from 8 to 11 for Liberia, Indonesia, Burundi, Ghana, Senegal and Morocco. At the other extreme, the degree of apparent uncertainty about assignment to short or long intervals is strikingly (and perhaps surprisingly) low for Zimbabwe.

The extent of imprecision in the dating of births of those children who have died is substantial (table 9). Over 20 per cent of all dead children cannot be unequivocally assigned to having been born after short or long intervals for Mali, Togo, Thailand, Senegal, Ghana, Egypt, and Burundi; the birth intervals for 12 per cent or more of dead children are not clearly classifiable in Indonesia, Sri Lanka, Tunisia, Liberia, Bolivia, and Morocco; these proportions are 7 per cent or lower in the remaining 12 countries.

The final panel of table 9 shows that dates of birth and preceding intervals are much more likely to be imprecise for deceased children than for those still alive (with the exception of Uganda). This is shown by the ratios of the proportions of dead children with imprecise dates to the proportion of all births with imprecise dates. Thailand is perhaps the most extreme example, with deaths being more than six times as likely to be imprecisely dated than births.

TABLE 9. PROPORTIONS OF BIRTHS AND DEATHS IN IMPRECISE INTERVALS SINCE PREVIOUS BIRTH

(Per thousand)

Country	Births, by months of interval						Deaths, by months of interval						Ratio: deaths/births, by months of interval					
	1-17	18-23	24-47	48-71	72+	All	1-17	18-23	24-47	48-71	72+	All	1-17	18-23	24-47	48-71	72+	All
Bolivia	35	51	33	26	26	36	79	143	127	165	297	121	2.3	2.8	3.8	6.2	11.2	3.4
Brazil	9	23	13	1	1	12	28	144	87	12	0	60	3.1	6.2	6.6	15.3	0.0	5.1
Colombia	1	18	5	0	0	6	0	138	49	0	0	45	0.0	7.5	9.6			7.8
Dominican Republic	2	20	9	0	0	8	7	74	35	0	0	27	4.9	3.7	4.0			3.5
Ecuador	10	45	25	1	2	21	19	98	98	31	0	59	1.9	2.2	3.9	21.3	0.0	2.8
Guatemala	15	45	20	0	3	21	28	120	97	0	38	72	1.9	2.7	5.0		13.5	3.4
Mexico	2	12	5	0	0	5	2	48	36	0	0	23	1.1	3.8	6.8			4.5
Peru	7	18	9	0	0	9	22	65	44	0	0	38	3.2	3.7	4.7			4.2
Trinidad and Tobago	2	5	2	7	5	3	19	158	30	63	0	46	8.3	34.4	18.4	9.6	0.0	13.9
Egypt	57	306	143	7	3	128	54	427	415	43	18	218	0.9	1.4	2.9	5.9	5.8	1.7
Morocco	16	128	108	6	16	84	30	198	157	54	154	119	1.8	1.5	1.4	9.0	9.4	1.4
Tunisia	37	43	25	10	27	30	104	172	187	74	364	147	2.8	4.0	7.3	7.1	13.2	4.9
Botswana	54	45	14	10	5	19	96	77	69	41	0	70	1.8	1.7	5.1	4.2	0.0	3.6
Burundi	51	206	91	4	1	97	61	337	232	29	14	214	1.2	1.6	2.5	7.0	14.3	2.2
Ghana	202	306	97	5	3	118	254	350	221	9	26	220	1.3	1.1	2.3	1.9	9.9	1.9
Kenya	15	31	13	6	8	16	31	85	53	58	76	55	2.0	2.7	4.1	9.5	9.5	3.4
Liberia	43	133	79	18	18	74	58	200	173	59	121	143	1.4	1.5	2.2	3.2	6.6	1.9
Mali	451	646	399	141	208	420	392	610	470	428	627	473	0.9	0.9	1.2	3.0	3.0	1.1
Senegal	85	242	103	5	14	116	93	350	245	13	37	233	1.1	1.4	2.4	2.8	2.6	2.0
Togo	325	597	194	19	16	231	485	718	363	58	100	394	1.5	1.2	1.9	3.1	6.2	1.7
Uganda	0	2	56	0	0	32	5	3	2	0	0	3		1.5	0.0			0.1
Zimbabwe	8	3	2	1	7	3	19	9	10	0	0	11	2.4	3.2	4.9	0.0	0.0	3.7
Indonesia	37	200	85	1	0	81	52	359	222	5	0	181	1.4	1.8	2.6	5.4		2.2
Sri Lanka	41	73	32	8	10	35	116	235	151	176	56	155	2.9	3.2	4.8	21.7	5.7	4.4
Thailand	112	84	50	27	34	60	284	531	397	312	333	370	2.5	6.3	7.9	11.4	9.9	6.2
Mean 25 DHS	65	131	65	12	16	67	94	226	159	65	90	140	2.2	4.1	4.7			3.6

Source: Demographic and Health Surveys individual recode files.

NOTE: 15 years before DHS.

How damaging are these findings for the study of associations between length of preceding interval and child survival? Perhaps surprisingly, table 10 shows that these very strong associations between imprecise dating and child survival have little impact upon the estimated patterns of relative risk. The relative risks of child death are shown for an analysis restricted only to firmly dated preceding intervals (those which could unequivocally be assigned to one side or other of a boundary at two years) and for the analysis based on all intervals. The selective association of imprecise dating with child deaths means that the estimated mortality rates based only on the firmly dated intervals will be too low.

However, the relative risks of child death by length of the preceding interval seem to be fairly robust. Indeed, the likely inferences concerning the broad patterns of relative risks only change in three countries, Thailand, Trinidad and Tobago, and Togo, where the already weak excess mortality for children born 18-23 months after the previous birth disappears. That these three countries should be most affected by this restriction to firmly dated intervals should come as no surprise: dead children in Thailand are about six times more likely to be removed from the analysis than survivors because of imprecise dating (37 per cent of dead children are removed from the analysis, and only 6 per cent of all births); in Trinidad and Tobago dead children are 14 times as likely to be removed, even though the proportions are lower; and in Togo the extent of imputation is quite severe and dead children are 70 per cent more likely to be removed. Otherwise, there is a slight and very consistent tendency for the relative risk for the 1-17 month interval category to rise with the restriction to firmly dated intervals (perhaps an artefact of the concentration on the division at two years for defining imprecise intervals, which leads to a greater proportionate removal from the 18-23 month and 24-47 month categories in most countries).

One must stress that because DHS has made it possible to recover the imputation range for all dates reported, there is scope for empirical examination of imprecise dating. The limited use of such information here suggests that the findings on relative risks of mortality by length of the preceding birth interval are surprisingly robust, even to fairly extensive imputation. This provides empirical confirmation of the simulation results presented by Trussell (1987), which also suggested such robustness to selective imprecision of dating by child survival status. Of course, machine imputation of dates may only be the tip of the iceberg. DHS files, unsurprisingly, contain no record concerning the extent of questioning and agreement between the respondent and the interviewer and the amount of field imputation of dates.

F. Analysis by family formation pattern

Thus far, patterns of child-bearing by age of the mother and by length of the preceding interval have been examined separately. In this section, 10 family formation patterns are used to try to examine the overall impact of these variables representing the timing of births. The classification includes an attempt to distinguish the concentration of all previous births for mothers aged 20-34, by classifying women into "pace of previous reproduction" groups. This classification proved useful in an earlier, related analysis (Hobcraft, 1987), and has been found helpful in multivariate analysis for Mexico (Bobadilla, Schlaepfer and Alagon, 1990).

The family formation pattern is derived as follows, for all births to mothers aged under 35 at the time of the birth (births at higher ages are excluded because of the heavy censoring of experience during the 15 or so years before the surveys for this group). Births are initially divided into first and higher order groups. The first births are subdivided into those to teenage mothers and the rest. Later births (a term used for second and higher order births) are divided according to whether the preceding birth interval is less than two years ("poor" spacing or "short" intervals) or not ("well" spaced or "long" intervals). Each of these two categories of later births is further subdivided into four: births to teenage mothers, and three categories of births to mothers aged 20-34, namely those who are "slow", "medium" and "fast" reproducers up to the time of the birth in question. "Slow" reproducers have two births if aged 20-24,

TABLE 10. RELATIVE RISKS OF DEATH BY AGE 5 FOR FIRMLY DATED AND FOR ALL PRECEDING INTERVALS, BY GROUPED LENGTH OF INTERVAL *(24-47 = 100)*

Country	Firmly dated intervals (months)					All intervals (months)					Ratio: all/firmly dated intervals (months)				
	1-17	*18-23*	*24-47*	*48-71*	*72+*	*1-17*	*18-23*	*24-47*	*48-71*	*72+*	*1-17*	*18-23*	*24-47*	*48-71*	*72+*
											(percentage)				
Bolivia	226	148	100	66	42	214	148	100	70	53	95	100	100	106	124
Brazil	274	139	100	102	57	259	146	100	96	53	94	105	100	93	92
Colombia	210	122	100	67	51	200	132	100	64	48	95	109	100	96	96
Dominican Republic	199	116	100	77	126	195	120	100	75	123	98	103	100	97	97
Ecuador	233	117	100	64	61	218	114	100	61	56	93	97	100	95	92
Guatemala	284	145	100	69	90	264	144	100	63	86	93	99	100	92	95
Mexico	202	129	100	76	65	195	130	100	74	63	97	100	100	97	97
Peru	200	142	100	64	30	195	144	100	61	29	98	101	100	96	96
Trinidad and Tobago	218	91	100	124	87	216	105	100	128	85	99	115	100	103	97
Egypt	455	208	100	80	97	313	170	100	57	68	69	82	100	71	70
Morocco	224	121	100	52	50	216	125	100	52	55	97	103	100	100	111
Tunisia	310	156	100	69	48	278	150	100	62	62	90	96	100	89	129
Botswana	292	134	100	68	86	288	131	100	66	82	99	98	100	98	94
Burundi	193	125	100	63	52	168	127	100	56	45	87	101	100	89	87
Ghana	155	140	100	94	82	144	129	100	83	74	93	92	100	88	90
Kenya	200	120	100	64	44	195	122	100	64	45	97	102	100	101	103
Liberia	164	130	100	71	43	150	126	100	67	42	91	97	100	94	100
Mali	239	168	100	42	29	200	136	100	61	57	84	81	100	144	195
Senegal	157	116	100	77	80	135	113	100	66	71	86	97	100	86	88
Togo	148	100	100	107	109	155	113	100	92	96	105	112	100	85	88
Uganda	171	145	100	85	63	172	145	100	85	63	100	100	100	100	100
Zimbabwe	238	149	100	73	91	238	149	100	72	90	100	100	100	99	98
Indonesia	217	118	100	78	83	188	125	100	67	71	87	106	100	86	86
Sri Lanka	207	124	100	88	131	198	131	100	92	121	95	106	100	105	92
Thailand	321	89	100	90	106	253	112	100	82	96	79	125	100	90	91
Mean 25 DHS	230	132	100	76	72	210	131	100	73	69	93	101	100	96	100

Source: Demographic and Health Surveys individual recode files.
NOTE: 15 years before DHS.

two or three if aged 25-29, and two to four births if aged 30-34. The "medium" group contains 20-24-year-olds with three births, 25-29-year-olds with four or five births, and 30-34-year-olds with five or six children. The "fast" category comprises 20-24-year-olds with four or more births, 25-29-year-olds with six or more, and 30-34-year-olds with seven or more births.

The distribution of births across these 10 categories is given in table 11 for each of the 25 DHS considered. The overall proportion of first births is strongly inversely correlated with the fertility level, being highest (at about a third of all births to women under age 35 during the 15-year period covered) in Thailand, Trinidad and Tobago, and Sri Lanka. First births constitute only a fifth of the total sample for Kenya, Mali and Morocco. There is striking variability in the fractions of first births which occur to teenage mothers: about two thirds for Kenya, Liberia, Mali, Senegal, Togo and Uganda; and under a quarter for Tunisia and Sri Lanka (in a previous

TABLE 11. DISTRIBUTION OF BIRTHS TO WOMEN AGED UNDER 35 IN 10 FAMILY-FORMATION CATEGORIES
(Per thousand)

			Later births							
	First births		*Well-spaced*				*Poorly-spaced*			
Country	*Teen*	*20-34*	*Teen*	*Slow*	*Medium*	*Fast*	*Teen*	*Slow*	*Medium*	*Fast*
Bolivia	115	135	21	198	161	82	35	96	91	67
Brazil	108	197	14	192	93	58	39	112	84	105
Colombia	134	175	20	183	111	68	45	99	80	84
Dominican Republic	147	126	30	152	114	94	57	83	90	107
Ecuador	129	137	23	177	139	80	44	95	81	95
Guatemala	135	95	36	168	171	108	48	73	85	81
Mexico	128	131	24	163	131	99	55	86	85	98
Peru	109	135	21	167	146	97	37	99	92	97
Trinidad and Tobago	136	190	15	212	105	44	50	108	77	64
Egypt	96	125	24	155	149	115	51	96	87	101
Morocco	92	119	19	150	180	125	35	90	95	94
Tunisia	53	185	2	203	166	64	13	152	101	60
Botswana	192	105	33	253	213	59	22	35	56	31
Burundi	87	149	13	246	214	65	15	83	82	45
Ghana	142	109	32	235	223	84	23	44	61	46
Kenya	137	62	49	129	195	147	41	48	82	110
Liberia	176	91	54	158	148	102	52	55	73	92
Mali	137	72	48	137	166	133	57	54	87	109
Senegal	154	74	55	157	210	136	37	40	66	71
Togo	155	88	43	211	229	101	22	39	62	49
Uganda	166	55	58	108	182	156	53	41	75	107
Zimbabwe	149	99	38	198	218	107	26	47	64	53
Indonesia	144	120	36	205	176	87	34	69	69	62
Sri Lanka	75	249	11	275	128	39	15	126	58	25
Thailand	124	226	13	261	128	35	21	111	56	25
Mean 25 DHS	129	130	30	187	164	92	37	79	77	75
Mean 18 WFS	118	106	31	152	157	107	46	78	91	115

Sources: Demographic and Health Surveys and World Fertility Survey individual recode files and John Hobcraft, "Does family planning save children's lives?", Technical paper for the International Conference on Better Health for Women and Children through Family Planning, Nairobi, 5-9 October 1987.

NOTE: 15 years before DHS.

study (Hobcraft, 1987), using WFS data, these fractions ranged from 88 per cent for Bangladesh down to only 9 per cent for the Republic of Korea).

The overall fractions of poorly spaced births among all births to women under age 35 also vary considerably, being below 20 per cent in Botswana, Ghana, Togo and Zimbabwe, and about a third for Brazil, Dominican Republic, Mexico, Peru, Egypt and Tunisia. Well-spaced later births, the remaining broad category, constitute a large proportion of all births. Over half of the births fall into this category for Botswana, Burundi, Ghana, Kenya, Senegal, Togo, Uganda, Zimbabwe and Indonesia. Fewer than 40 per cent of all births to women under age 35 in Brazil, Colombia, Dominican Republic, and Trinidad and Tobago are well spaced later births.

To achieve the most desired pattern of childbearing, namely, for all births to be to mothers aged 20-34 years, and to be well-spaced, major changes will be required in the countries examined here. By this criterion, Sri Lanka has the most favourable family formation pattern, with just over two thirds of all births before age 35 being in this advantaged category. Fewer than half of all births occurring in the Dominican Republic and Liberia meet this criterion.

The fraction of women who are classified as "fast" reproducers at the time of a birth is determined by a combination of the timing of the initiation of childbearing and the overall fertility level. As might be expected, short preceding intervals are much more common among this group and even more so for teenage later births (derived from table 11).

These family formation patterns can also be examined for the eight countries for which results from both WFS and DHS are available. Table 12 shows the distributions of births across the 10 categories. Despite the fact that the periods of observation overlap, often considerably, the changes in family formation patterns are striking. Without exception, the fraction of first births has increased, although the change is small for Kenya, Senegal and Morocco, and only moderate for Peru.

Four countries show substantial changes in the fractions of first births to mothers aged under 35 years, and thus in levels of fertility: Thailand (an increase from 23 to 35 per cent of the births), Sri Lanka, Colombia, and Trinidad and Tobago. Each of these four countries also shows a big reduction in the proportion of births which are poorly spaced (8 to 14 percentage points or about 30 per cent reductions). The extent of fertility decline is also evidenced by the shifts in the distribution of later births across the pace of reproduction categories: the fractions of later births to women aged 20-34 which are to slow reproducers go up by 15 to 24 percentage points; the proportions attributed to fast reproducers reduce by 9 to 18 percentage points. The changes in family formation patterns for the four countries with the largest changes are towards patterns that would be expected to be more favourable to child survival. The only minor exception is that the proportion of births which are first births to teenage mothers has gone up (by about 2 percentage points) in all but Sri Lanka.

Changes in Senegal are mainly in the opposite direction, although neither the overall proportion of first births nor the distribution of later births across the pace of reproduction categories change much, suggesting that fertility levels have barely altered. But the fraction of births which are poorly spaced has risen noticeably (by four percentage points or 21 per cent), suggesting that traditional post-partum restraints on spacing of births are eroding.

The relative risks of child death associated with the family formation patterns are shown in table 13, using well-spaced births to mothers aged 20-34 as the reference category. There is clear evidence of excess risks associated with teenage first births everywhere. The average excess risk for teenage first births is 47 per cent. For first births to 20-34-year-old mothers there is a small excess risk compared to well-spaced births for the same age group. This latter excess is larger for Guatemala, Kenya, Mali and Tunisia, at over 20 per cent, and there is an apparent clear relative advantage (better than 10 per cent below the reference group) for first births to 20-34-year-old mothers in Bolivia, Colombia, Dominican Republic, Mexico, Peru and Botswana.

For well-spaced later births to women aged 20-34, the relative risks must average 100. For teenage mothers the sample sizes of second and higher order

TABLE 12. COMPARISON OF DATA FROM WORLD FERTILITY SURVEY AND DEMOGRAPHIC AND HEALTH SURVEYS ON DISTRIBUTION OF BIRTHS TO WOMEN AGED UNDER 35 IN 10 FAMILY-FORMATION CATEGORIES

(Per thousand)

			Later births							
	First births		*Well-spaced*				*Poorly-spaced*			
Country	*Teen*	*20-34*	*Teen*	*Slow*	*Medium*	*Fast*	*Teen*	*Slow*	*Medium*	*Fast*
Colombia										
WFS	113	111	21	107	99	99	59	102	116	172
DHS	134	175	20	183	111	68	45	99	80	84
Peru										
WFS	98	109	19	143	145	105	40	101	112	127
DHS	109	135	21	167	146	97	37	99	92	97
Trinidad and Tobago										
WFS	117	142	18	132	97	88	56	100	100	151
DHS	136	190	15	212	105	44	50	108	77	64
Morocco										
WFS	105	83	25	105	159	156	59	68	100	140
DHS	92	119	19	150	180	125	35	90	95	94
Kenya										
WFS	134	62	46	111	166	137	53	62	102	127
DHS	137	62	49	129	195	147	41	48	82	110
Senegal										
WFS	156	51	60	138	261	159	33	26	51	67
DHS	154	74	55	157	210	136	37	40	66	71
Sri Lanka										
WFS	84	140	24	173	168	111	33	96	86	86
DHS	75	249	11	275	128	39	15	126	58	25
Thailand										
WFS	92	139	11	191	188	71	24	108	105	71
DHS	124	226	13	261	128	35	21	111	56	25
Mean										
WFS	112	105	28	138	160	116	45	83	97	118
DHS	120	154	26	192	150	86	35	90	76	71

Sources: Demographic and Health Surveys and World Fertility Survey individual recode files and John Hobcraft, "Does family planning save children's lives?", Technical paper for the International Conference on Better Health for Women and Children through Family Planning, Nairobi, 5-9 October 1987.

NOTE: 15 years before DHS and WFS.

births are usually small and the estimated relative risks need to be treated with caution since they are typically subject to large sampling variability. Nevertheless, an average excess risk of about a third (over all 25 countries) emerges for this group. For the well-spaced births to mothers aged 20-34, some differences by pace of reproduction do emerge. Relative risks are usually a little lower for the slow reproducers (eight per cent on average). The fast reproducers show evidence of excess risk, with the average excess being 22 per cent, and several countries exhibiting bigger excess risks. The gradient across the pace of reproduction categories for well-spaced later births to 20-34-year-old mothers is quite clear and sizeable for Bolivia, Brazil, Colombia, Mexico and Peru; perhaps such differences in the Latin American countries arise from very high socio-economic inequalities, which also coincide with the current differentials in pace of reproduction (at an intermediate stage of the demographic transition). This finding should remind the reader to be cautious about the lack of socio-economic controls in this analysis, although part two of the report addresses some of these issues.

TABLE 13. RELATIVE RISKS OF DEATH BY AGE 5 FOR 10 FAMILY-FORMATION CATEGORIES
(Well-spaced births to 20-34 year old mothers = 100)

Country	Well-spaced rate, 20-34 year old mothers	First births		Well-spaced				Poorly-spaced				Population attributable risk
		Teen	20-34	Teen	Slow	Medium	Fast	Teen	Slow	Medium	Fast	
Bolivia	111	118	88	145	83	101	140	223	169	194	237	130
Brazil	61	173	96	245	86	105	138	314	176	228	338	162
Colombia	46	130	78	107	69	106	174	258	133	163	238	127
Dominican Republic	68	147	87	107	109	103	82	210	118	135	225	130
Ecuador	72	139	107	74	88	105	119	213	129	218	217	134
Guatemala	84	173	124	156	105	88	111	274	168	212	256	150
Mexico	58	116	59	131	71	103	143	223	120	163	246	125
Peru	86	145	76	143	79	99	137	226	120	246	229	135
Trinidad and Tobago	26	162	117	205	96	91	140	283	139	164	172	136
Egypt	81	212	115	167	86	97	122	366	203	281	361	180
Morocco	95	168	114	108	96	101	104	240	154	166	201	134
Tunisia	51	158	130	82	93	102	119	285	168	230	362	150
Botswana	54	106	87	97	88	117	91	226	180	190	222	114
Burundi	166	134	104	125	98	95	123	161	150	157	141	115
Ghana	132	135	108	154	94	101	114	142	173	141	146	116
Kenya	70	154	127	153	96	91	116	199	96	156	203	131
Liberia	184	150	105	133	98	90	118	173	134	159	152	126
Mali	208	164	128	136	93	103	104	216	166	184	197	141
Senegal	203	120	101	117	97	101	102	136	100	120	144	110
Togo	144	125	105	123	93	100	116	181	118	127	132	111
Uganda	143	156	113	129	107	96	100	170	161	149	160	128
Zimbabwe	65	149	115	148	91	98	120	226	146	172	256	129
Indonesia	94	136	98	135	96	93	126	235	124	161	198	123
Sri Lanka	37	127	108	150	96	107	103	164	118	230	281	120
Thailand	39	148	104	108	90	93	202	239	163	222	320	129
Mean 25 DHS		147	104	135	92	99	122	223	144	182	225	132
Mean 18 WFS		150	108	126	93	100	113	203	135	171	208	134

Sources: Demographic and Health Surveys and World Fertility Survey individual recode files.
NOTE: 15 years before DHS.

Poorly-spaced later births typically experience considerable excess risks of death before age five. Even for slow reproducers there is a 44 per cent average excess risk for poorly spaced births, compared with all well-spaced births to 20-34-year-old mothers, or a 56 per cent excess compared with well-spaced births for slow reproducers. For those poorly spaced later births which occur to women with a medium pace of reproduction, the average excess risk is 82 per cent. If the relative risk for poorly-spaced births to fast reproducers is compared just to that for well spaced births to fast reproducers, the excess is 84 per cent; compared with all well-spaced later births to mothers aged 20-34 the average relative risk is 225, an excess of 125 per cent. Poorly-spaced births to teenage mothers also experience high risks of death, being more than twice as likely on average to die before age five than a child born to a woman in

the reference group; compared with well-spaced births to teenage mothers the average excess risk is 65 per cent.

Brazil and Egypt stand out as having extraordinarily high excess risks, both for births occurring to teenagers and for poorly spaced births. Tunisia and Thailand also show extreme excess risks for poorly spaced births. Excess risks are small in Senegal and Togo, and generally low in the other high mortality countries (Burundi, Ghana and Liberia), although Mali (perhaps because of its severe dating problems) is an exception. However, a 40 per cent excess risk leads to a lot of excess deaths when applied to a baseline rate of about 200 per 1,000, raising the mortality by 80 per 1,000. It is thus not surprising that the relative risks are a little more modest in such circumstances. Only Mali provides a puzzle in this respect, with much higher excess risks and the highest baseline mortality rate.

The comparison of mean values for the relative risks derived from 18 WFS countries and 25 DHS countries shows very broad agreement. If anything, the excess risks associated with short birth intervals are a little higher for the more recent DHS surveys.

G. Implications at the population level

The overall effect of the family formation patterns and their associated risks is summarized by the population attributable risks given in table 13. Brazil, Guatemala, Egypt and Tunisia all have a combination of high relative risks and unfavourable family formation patterns leading to major excess child mortality (the population attributable risks are 162, 150, 180 and 150 respectively). Experience in other countries suggests that these might be reduced to around 130, if all or most of the excess is indeed attributable to the factors considered here. Better timing of first births and spacing of subsequent births through family planning might lead to a significant, possibly 30 per cent, reduction in child mortality for Egypt.

Low relative risks and moderately favourable family formation patterns for Botswana, Burundi, Ghana, Senegal and Togo result in fairly low population attributable risks. This contrasts with Mali, where the population attributable risk is 141, but where the results may be due to data quality problems.

There is a more important concern for several sub-Saharan African countries. With the onset of fertility transition in Botswana, Burundi, Ghana, Senegal or Togo, family formation patterns may well become less favourable for child survival. Owing to erosion of traditional post-partum fertility constraints, more births are likely to occur at short intervals, with a possible concomitant rise in fertility (see Dyson and Murphy, 1985). Moreover, the relative risks for these high mortality countries are unusually low. As overall levels of mortality are reduced, it seems quite plausible that these relative risks will rise (the scope for differential survival being greater at moderate levels of child mortality). Population attributable risks associated with family formation patterns are therefore likely to rise in these societies over the next 10 or 20 years and could particularly or completely offset mortality gains from other interventions. There is thus a need for family planning programmes in these countries to emphasize child-spacing.

A comparison of results for WFS and DHS for Senegal (see table 14), shows that the child mortality rate for the baseline group in Senegal has reduced from 261 per 1,000 to 203 per 1,000, a significant improvement. But the relative risks for the typically higher risk groups have increased. There has also been a worsening of child-spacing for Senegal over time. The combined effect of the less favourable family formation patterns and the increased relative risks associated with them is to raise the population attributable risk from 101 to 110. The observed overall gain in child survival over the eight years between the surveys (and with some seven years of experience in common) is from 263 per 1,000 to 223 per 1,000, a 15 per cent reduction (see table 15). But mortality for well-spaced births to 20-34-year-old mothers was reduced from 261 per 1,000 to 203 per 1,000, a 22 per cent reduction. Without the changes in family formation patterns, the overall mortality rate might have been reduced by a further 20 per

TABLE 14. COMPARISON OF DATA FROM WORLD FERTILITY SURVEY AND DEMOGRAPHIC AND HEALTH SURVEYS ON RELATIVE RISKS OF DEATH BY AGE 5 FOR 10 FAMILY-FORMATION CATEGORIES

(Well-spaced births to 20-34-year old mothers = 100)

Country	Well-spaced rate, 20-34 year old mothers	First births		Well-spaced				Poorly-spaced				Population attributable risk
		Teen	20-34	Teen	Slow	Medium	Fast	Teen	Slow	Medium	Fast	
Colombia												
WFS	70	135	97	174	115	91	92	238	153	156	202	143
DHS	46	130	78	107	69	106	174	258	133	163	238	127
Peru												
WFS	127	122	76	102	85	96	126	183	141	166	204	128
DHS	86	145	76	143	79	99	137	226	120	246	229	135
Trinidad and Tobago												
WFS	34	148	99	102	80	103	127	165	92	153	264	139
DHS	26	162	117	205	96	91	140	283	139	164	172	136
Morocco												
WFS	102	176	112	97	110	84	110	233	151	194	212	145
DHS	95	168	114	108	96	101	104	240	154	166	201	134
Kenya												
WFS	110	159	127	124	89	96	114	198	131	161	171	133
DHS	70	154	127	153	96	91	116	199	96	156	203	131
Senegal												
WFS	261	107	79	104	94	103	100	123	66	102	103	101
DHS	203	120	101	117	97	101	102	136	100	120	144	110
Sri Lanka												
WFS	70	139	84	114	95	94	118	169	94	141	167	113
DHS	37	127	108	150	96	107	103	164	118	230	281	120
Thailand												
WFS	75	132	118	120	105	95	102	228	129	208	222	132
DHS	39	148	104	108	90	93	202	239	163	222	320	129
Mean												
WFS	106	140	99	117	97	95	111	192	120	160	193	127
DHS	75	144	103	136	90	99	134	218	128	183	223	129

Sources: Demographic and Health Surveys and World Fertility Survey individual recode files and John Hobcraft, "Does family planning save children's lives?", Technical paper for the International Conference on Better Health for Women and Children through Family Planning, Nairobi, 5-9 October 1987.

NOTE: 15 years before DHS and WFS.

1,000, or a 50 per cent increase in the mortality improvement. Such considerations are clearly not of negligible importance. Of course, some caution is required, since the assumptions involved in these illustrative calculations are strong: the estimates from both surveys are taken as accurate, or at least similarly deficient; all changes in relative risks and all excess mortality observed for family formation groups is taken to be caused solely by the child-bearing patterns and not by associated variables.

Comparisons over time are given in table 14 for the other seven countries where results are available from both WFS and DHS. Population attributable risks have also increased modestly over time for Peru and Sri Lanka. Yet the distribution of births across the family formation categories in both these countries had become more favourable, slightly so for Peru and significantly so for Sri Lanka (table 12). Closer examination of the patterns responsible for these changes does not provide a coherent story. For Sri Lanka, the overall rise in the population attributable risk is mainly due to a worsening of relative risks for two categories which gained a considerable fraction of births: the relative risks for 20-34-year-old first births and for poorly-spaced births to slow

reproducers both rose from especially low levels to more normal ones. For Peru, the increase in the fraction of first births to teenage mothers was combined with a slightly higher relative risk, and the relative risk for poorly-spaced births to medium-pace reproducers unaccountably rose.

A comparison of population attributable risks between WFS and DHS over the 10 family formation categories show that the largest change has occurred in Colombia. Over an effective ten-year period (and with an overlap of five years), the child mortality rate for the well-spaced births to mothers aged 20-34 went from 70 per 1,000 to 46 per 1,000, a reduction of 34 per cent. But overall child mortality (for the entire samples considered here) fell from 100 per 1,000 to 58 per 1,000, a reduction of 42 per cent. If there had been no improvement in child mortality associated with family formation patterns, the overall rate might have been reduced to only 66 per 1,000. The extra reduction corresponds to about a quarter of the observed gain, and might be attributed mainly to improvements in the family formation pattern and perhaps thus be due to family planning. Caution is urged in such interpretation without much more elaborate analysis. Another curious feature of the changes for Colombia is the alteration in the pattern of relative risks across the reproductive pace categories for well-spaced births (not including those to teenagers). For the 15 years preceding WFS, there appears to be little differentiation in these relative risks, but DHS data show a larger differential by reproductive pace for these well-spaced births.

Patterns of change over time for the eight countries where information was available both from WFS and DHS are examined further in table 15. The first two columns show the observed overall child mortality rates for the entire samples (restricted to births to women under age 35 and, in different ways for the two data sources, to experience covering the 15 years before the surveys). The next column shows DHS rate as a percentage of WFS rate and thus indicates the extent of overall decline in mortality. This measure of change in the mortality rates can further be subdivided into two components: the percentaged ratio of the change in the baseline rate for well-spaced births to 20-34-year-old mothers; and the percentaged ratio of the population attributable risks for the two periods. The product of these components is precisely the ratio of the overall rates.

TABLE 15. ACTUAL CHANGES IN MORTALITY RATES UNDER AGE 5 AND COMPONENTS OF CHANGE

Country	*Observed mortality rate*		*Ratio of mortality rates*		*Ratio of population attributable risks (percentage)*	*Percentage change due to changes in:*			
	WFS	*DHS*	*All births (percentage)*	*Well-spaced births*		*Fertility structure (using DHS relative risks)*	*Relative risk (using WFS structure)*	*Fertility structure (using WFS relative risks)*	*Relative risk (using DHS structure)*
Colombia	100	58	58	66	88	85	104	92	96
Peru	162	116	72	68	106	94	112	96	111
Trinidad and Tobago	47	35	75	76	98	94	105	87	113
Morocco	148	127	86	93	92	94	97	94	98
Kenya	146	92	63	63	99	97	102	97	102
Senegal	263	223	85	78	109	100	109	99	111
Sri Lanka	79	44	55	53	105	88	120	91	117
Thailand	99	50	51	52	99	88	113	94	105
Mean			68	69	100	93	108	94	106

Sources: Demographic and Health Surveys and World Fertility Survey individual recode files and John Hobcraft, "Does family planning save children's lives?", Technical paper for the International Conference on Better Health for Women and Children through Family Planning, Nairobi, 5-9 October 1987.

NOTE: Comparison for 15 years before DHS and WFS.

Thus, it can be observed that the 42 per cent overall decline in Colombia resulted from a 34 per cent decline for the baseline group, reinforced by a 12 per cent reduction in the population attributable risk. The 14 per cent overall decline in Morocco was about equally attributable to declines in the baseline rate and in the population attributable risk, whereas the entire declines in Kenya and Thailand are attributable to across the board mortality changes and are not associated with family formation patterns.

Table 15 also shows alternative partitions of the ratio of the population attributable risk into one component due to changes in the structure and another due to alterations in risk patterns across the family formation groups obtained by simple standardization. In most cases the alternative partitions tell the same story (e.g., Peru, Kenya, Morocco and Sri Lanka). For Peru and Sri Lanka, both considered earlier, the rise in the population attributable risks is clearly attributed to the changes in the patterns of relative risks, which can be seen to more than counterbalance gains from improvements in the structures. As noted before, the structural gains in Sri Lanka were not negligible: on their own they would have accounted for about a 10 per cent overall reduction in child mortality.

These partitions tell a consistent story. With the exception of Senegal, where structural change was about neutral, there were improvements in the distribution of births or fertility structure for all countries, with the net effect being about a 10 per cent overall gain in child survival from structural change in Colombia, Trinidad and Tobago, Sri Lanka and Thailand. But in most places these structural gains were offset, partially or completely, by a worsening of the relative risk patterns implying increased differentials in child survival. Only Morocco shows evidence of a small overall improvement in relative risk patterns by family formation group; there is doubt for Colombia, depending upon which partition is used.

H. Analysis by broad risk groups

In this section, a simpler subdivision into three "broad risk groups" of births, at low, intermediate and high levels of risk is introduced. The low risk group includes first births to mothers aged 20-34 and all higher-order births to women in this age group which occurred at intervals of two or more years after the preceding birth. This group is used as the reference group for comparisons and has the considerable advantage of being a realizable target: a policy which advocated delaying child-bearing until at least age 20, followed by avoidance of poorly-spaced births, could in principle be achieved. The intermediate risk group is made up of first and well-spaced subsequent births to teenage mothers and slow-paced, poorly-spaced births to mothers aged 20-34 (pace refers to the pace of the total number of births before the current one; see above). Finally, the high risk group is composed of poorly-spaced births to teenage mothers and poorly-spaced, medium- and fast-paced births to 20-34-year-old mothers.

The relative risks and the distribution of births across this three-fold classification for the 25 DHS are shown in table 16. In very broad terms, the intermediate group shows an average relative excess risk of mortality by age five of around 40 per cent (both in DHS and in 18 WFS used in Hobcraft, 1987). The high risk group of children are about twice as likely to die before age five than those in the low risk group. These averages mask considerable variation among the 25 countries.

The excess risks are strikingly high in Brazil and Egypt, with child mortality for the high risk group being approximately three times that for the low risk group and that for the intermediate group being almost doubled. These two countries stand well clear of the others. Brazil and Egypt also have quite substantial proportions of births occurring in the higher risk groups, about 23 per cent in each of the two groups. Relatedly, the fraction of births in the low risk group is fairly (though not strikingly) low at

about 54 per cent. The combination of the extremely high excess risks with moderately high proportions of births experiencing these higher risks is summarized by the population attributable risks, showing a 73 per cent excess for Egypt and 64 per cent excess for Brazil. In the unlikely event that all of this excess risk was entirely due to the timing of births (and not, for example, partially attributable to regional or socio-economic variation), the policy message would be most significant indeed: child mortality might be lowered by up to 40 per cent through improved timing of births; for Brazil, this could have reduced the 15-year average child mortality rate for DHS experience from 99 per 1,000 births to 60 per 1,000; for Egypt, the corresponding reduction is from 147 to 85. Considerable further work is required to provide a more realistic answer as to what fraction of these maximal gains from improved timing of births might be realizable in practice.

The countries of the Americas (other than Brazil) have reasonably consistent patterns in both the levels of excess risk and the distribution of births, resulting in population attributable risks ranging from 128 to 144. The features of this region typically include a doubling of risk of death for children in the high risk group, about a quarter of births falling into the intermediate group, and a fifth or more of births being in the high risk group. Tunisia, Mali and Morocco are similar to countries of the Americas in respect of the patterns shown, although there is a little more variability. The population attributable risks for the countries of the Americas and Northern Africa never fall below 128, and average about 136 if Brazil and Egypt are omitted (and 141 if they are included). For these two broad regions the potential gains from improved timing of births are thus moderate to considerable, although it is noted once again that all of the excess risk is not attributable to timing of births alone.

The countries from sub-Saharan Africa (excluding Mali) and Asia have more varied patterns, but have a key feature in common: all show a population attributable risk of 128 or less, which clearly differentiates them from the countries of the two broad regions considered in the previous paragraph. It is, of course, no accident that this differentiation also occurs in the pattern of child-spacing, as summarized in table 16. More than 36 per cent of all births of order two and higher occur at intervals of less than 24 months after the preceding birth for every country included from the Americas or Northern Africa; fewer than 36 per cent of births are poorly-spaced in every country shown from sub-Saharan Africa or Asia (derived from table 11).

The low population attributable risks for the sub-Saharan African countries arise in a variety of ways, with low relative risks for the high risk group (below 60 per cent excess) occurring for six out of nine countries, and fewer than 15 per cent of all births being in this group for five out of nine countries. The relative risks are moderately high for Botswana and Zimbabwe, and intermediate for Kenya; these are the three countries in this region which showed the greatest fertility decline during the 15 years being considered here (see table 1), although such a link may be coincidence. The fractions of high risk births are above 20 per cent for Kenya, Uganda and Liberia. These three countries are joined by Zimbabwe (with its higher relative risks, but more favourable birth distribution), to form a cluster of countries with population attributable risks of around 126, suggesting that there is some scope for improving levels of child mortality through altering the timing of births, albeit less than for the Americas or Northern Africa.

Population attributable risks are below 120 in the remaining five sub-Saharan African countries (Botswana, Ghana, Burundi, Senegal and Togo). The relative risks are low for all but Botswana. The fraction of high risk births is low for all but Senegal. A spectre often raised in this context is that the relatively favourable child-spacing patterns evident in these five countries (and in Zimbabwe) might worsen over time as a consequence of the abandonment of traditional post-partum restraints on fertility, thereby raising child mortality levels (see Hobcraft, 1987 and 1991, among others, for this theme). There is perhaps some reassurance to be gained from the experience of Botswana and Zimbabwe in this context, since both show evidence of significant fertility declines during the period covered by this analysis (see table 1) and, as table 17 shows, have moved towards more (rather than less) favourable patterns of child-bearing with fertility decline.

TABLE 16. RELATIVE MORTALITY RISKS BY AGE 5 AND BIRTH DISTRIBUTION FOR BROAD RISK GROUPS

Country	*Relative risks*			*Birth distribution (per 1,000)*			*Population attributable risk*
	Low risk	*Intermediate risk*	*High risk*	*Low risk*	*Intermediate risk*	*High risk*	
Brazil	100	182	297	538	234	227	164
Peru	100	142	251	545	228	227	144
Guatemala	100	163	231	545	242	213	143
Mexico	100	129	235	529	240	231	138
Colombia	100	137	229	537	253	210	136
Bolivia	100	147	221	576	232	193	134
Dominican Republic	100	138	196	486	260	254	134
Ecuador	100	126	212	533	247	220	131
Trinidad and Tobago	100	145	186	551	259	190	128
Egypt	100	195	322	545	216	239	173
Morocco	100	152	187	576	201	223	130
Tunisia	100	149	256	619	208	174	137
Mali	100	154	190	508	239	254	136
Kenya	100	138	180	532	234	233	128
Uganda	100	149	157	500	264	235	126
Zimbabwe	100	144	208	622	234	143	126
Liberia	100	142	158	499	284	217	124
Botswana	100	118	211	630	260	109	117
Ghana	100	144	141	651	218	131	115
Burundi	100	139	151	674	183	142	114
Senegal	100	116	133	576	249	175	110
Togo	100	123	137	630	237	133	110
Thailand	100	150	248	650	248	102	127
Indonesia	100	132	190	588	248	164	123
Sri Lanka	100	118	226	691	212	97	116
Mean 25 DHS	100	143	206	573	237	189	131
Mean 18 WFS	100	138	189	522	227	252	129

Sources: Demographic and Health Surveys individual recode files and John Hobcraft, "Does family planning save children's lives?", Technical paper for the International Conference on Better Health for Women and Children through Family Planning, Nairobi, 5-9 October 1987.

NOTE: "Low-risk" group comprises all well-spaced births and first births to 20-34-year-old mothers; "Intermediate-risk" group includes first and well-spaced subsequent births to teenage mothers and slow-paced poorly spaced births to 20-34-year-old mothers; "High-risk" group is composed of poorly spaced teenage births and poorly spaced medium and fast-paced births to 20-34-year-old mothers.

The experience covered by the analysis of DHS can be further subdivided into three time segments for each country, corresponding to the first and second five year periods covered by the analyses, and a remaining period of just over five years up to the time of the survey; the three time segments are labelled as approximately corresponding to the "early 1970s" (strictly covering periods from 1971-1975 for the earliest surveys to 1974-1978 for the most recent survey, Bolivia), the "late 1970s" (as late as 1979-1983 for Bolivia); and the "early 1980s" (from 1981-1986 to 1984-1989).

The relative risks and birth distribution for each five-year segment (five years for the most recent period) are given in table 17. There are striking and

TABLE 17. RELATIVE MORTALITY RISKS BY AGE 5 AND BIRTH DISTRIBUTION FOR BROAD RISK GROUPS AND CALENDAR PERIODS

Country	Relative risks									Birth distribution (per 1,000)								
	Low risk			Intermediate risk			High risk			Low risk			Intermediate risk			High risk		
	Early 1970s	Late 1970s	Early 1980s	Early 1970s	Late 1970s	Early 1980s	Early 1970s	Late 1970s	Early 1980s	Early 1970s	Late 1970s	Early 1980s	Early 1970s	Late 1970s	Early 1980s	Early 1970s	Late 1970s	Early 1980s
Bolivia	100	100	100	134	138	174	218	227	208	536	552	632	259	231	210	205	217	158
Brazil	100	100	100	188	162	211	261	264	360	470	547	580	243	222	240	287	231	180
Colombia	100	100	100	148	136	134	218	229	180	476	542	577	247	262	250	277	196	174
Dominican Republic	100	100	100	119	133	169	202	190	169	443	496	510	245	240	286	312	263	204
Ecuador	100	100	100	149	87	153	207	196	217	480	517	595	251	262	229	270	222	176
Guatemala	100	100	100	155	173	152	217	257	207	514	527	588	266	240	224	220	233	187
Mexico	100	100	100	123	138	132	226	212	246	461	530	604	250	244	224	290	226	172
Peru	100	100	100	142	155	140	216	274	261	521	528	580	229	234	223	250	238	197
Trinidad and Tobago	100	100	100	153	160	105	160	167	220	500	558	580	293	259	235	207	183	185
Egypt	100	100	100	191	211	190	278	324	333	489	537	594	220	217	213	291	245	193
Morocco	100	100	100	145	154	150	171	182	191	522	551	646	213	214	179	265	235	175
Tunisia	100	100	100	172	132	149	266	251	228	598	604	645	204	212	206	198	184	149
Botswana	100	100	100	119	113	119	255	226	129	576	604	688	286	274	231	138	121	80
Burundi	100	100	100	117	141	144	134	156	148	624	631	740	230	203	139	146	165	120
Ghana	100	100	100	127	169	137	134	150	138	589	637	705	248	221	195	163	142	100
Kenya	100	100	100	143	111	156	209	159	174	474	520	580	267	234	213	259	246	206
Liberia	100	100	100	159	153	125	167	176	137	449	469	552	301	303	257	250	228	191
Mali	100	100	100	136	157	174	171	195	193	461	461	590	269	237	216	269	302	193
Senegal	100	100	100	105	122	112	127	153	110	511	554	635	280	261	219	208	185	147
Togo	100	100	100	135	118	114	114	130	159	582	607	680	270	240	213	148	153	107
Uganda	100	100	100	174	141	147	209	162	130	449	467	552	289	270	247	262	263	201
Zimbabwe	100	100	100	121	160	148	201	204	202	548	611	680	277	235	206	175	155	114
Indonesia	100	100	100	156	123	118	196	190	169	542	556	657	259	267	221	199	177	122
Sri Lanka	100	100	100	127	129	100	244	221	174	687	684	703	202	217	215	111	99	82
Thailand	100	100	100	132	156	181	211	190	358	610	645	699	247	256	241	144	99	60
Mean 25 DHS	100	100	100	143	143	145	201	203	202	524	557	624	254	242	221	222	200	155

Sources: Demographic and Health Surveys individual recode files.

NOTE: "Low-risk" group comprises all well-spaced births and first births to 20-34-year-old mothers; "Intermediate-risk" group includes first and well-spaced subsequent births to teenage mothers and slow-paced poorly spaced births to 20-34-year-old mothers; "High-risk" group is composed of poorly spaced teenage births and poorly spaced medium and fast-paced births to 20-34-year-old mothers.

consistent changes over time in the distribution of births. The proportion of births in the high-risk category reduces for every single country over the 10-year span between the early to mid-1970s and the early to mid-1980s. During the earliest period, more than 21 per cent of births were in the high-risk category for 13 out of the 25 countries; by the most recent time segment, no country remained at this level. The greatest reductions in the fraction of high-risk births over that period were for seven (of 13) countries from the Americas and Northern Africa: Mexico, Dominican Republic, Brazil, Colombia, Egypt, Ecuador and Morocco. These seven countries all showed a reduction of 9 or more percentage points in the fraction of births in the high-risk group.

The smallest reductions in the proportions of high-risk births, of less than 5 percentage points occurred for Trinidad and Tobago, Guatemala, Bolivia and Tunisia, and three countries of sub-Saharan Africa and Asia (Burundi, Togo, and Sri Lanka). Guatemala and Bolivia have the highest recent fertility

levels among the countries of the Americas and show low decline over the 15-year period (see table 1); Trinidad and Tobago also shows little fertility decline, but had the lowest overall fertility level of the region. Burundi, Togo and Sri Lanka all began with fairly low proportions of births in the high-risk group, making major reductions unlikely (although the changes in Botswana and Thailand raise doubts about such an assertion).

Perhaps more surprising is the extent of the reduction in high-risk births for several sub-Saharan African countries where total fertility is still high and the evidence for declines in fertility within the 15-year period is weak. Uganda, Liberia, Ghana and Senegal all show reductions of about 6 percentage points in the incidence of high-risk births over the period, combined with only minor or non-existent fertility declines; this requires further investigation.

The patterns of change over time in the relative risks are much less clear than those in the distribution of births. The average excess risks across all 25 countries are more or less invariant over time with only a few exceptions which may either be chance fluctuations or interesting exceptions. Mali (with potentially severe data quality problems) and Thailand show a fairly consistent worsening of relative risks for both the intermediate and the high-risk groups over time. Togo (another country with severe data quality problems) also shows a worsening pattern of excess risks for the high-risk group. Uganda (which has poorer dating for surviving children than for dead ones) shows the opposite trend, with the excess mortality being reduced over time, especially and substantially for the high-risk group of births. Otherwise, patterns of change are more erratic (e.g., the sharp reduction in the most recent period for the high-risk group in Botswana, and the opposing moves for the most recent period in Trinidad and Tobago). It is doubtful whether these few exceptions to the general lack of change over time in excess risks of child mortality are really meaningful; they may rather result from chance fluctuations.

Table 18 provides the overall child mortality rates and the baseline rates for the low-risk groups, for each of the three time periods considered. Table 18 also provides the population attributable risks, which indicate the excess mortality that might be reduced in some part by improving the timing of births. The population attributable risks change favourably and consistently over time in several countries, being reduced by 15 percentage points or more between the early 1970s and the early 1980s in Uganda, Colombia, Indonesia, Liberia, Botswana, Tunisia and Sri Lanka. The changes in Uganda and Liberia, however, are significantly attributable to odd fluctuations in the level of child mortality for the baseline group. For Colombia, Indonesia and Tunisia the gains arise from improvements in the distribution of births and in the relative risks, with differing combinations over time. Only Thailand shows a moderate worsening of the population attributable risk from the early 1970s to the early 1980s, and this is entirely attributable to the sharp increases in relative risks for the most recent period, more than offsetting the gains through improved patterns of child-bearing (it is noted, however, that there are severe problems of date reporting for dead children in Thailand). A few countries show more erratic time trends.

Table 19 contrasts experience for 15 years before DHS with that of birth cohorts from the 15 years preceding WFS for eight countries where comparable results from WFS were at hand (Hobcraft, 1987). The periods of observation overlap, sometimes considerably. The fraction of high-risk births reduces substantially, by about 10 percentage points or more, in Colombia, Trinidad and Tobago, Sri Lanka and Thailand; in contrast, there is an increase in the proportion of high-risk births for Senegal. The excess risks widen consistently over time for Peru, Senegal, Sri Lanka and Thailand; on the other hand, Morocco shows a small improvement in excess risks over time.

The combined effect of these changes is provided by the population attributable risks, which show significant reductions for Morocco, Trinidad and Tobago, and Colombia. For Colombia and Trinidad and Tobago, big improvements in the birth distribution are partially offset by inconsistent changes in the relative risks. For Morocco, there is a moderate improvement in the birth distribution, reinforced by improvements in the excess risks. Two countries, Peru and Senegal, experience a significant worsening of their population attributable risks. For Peru, a

TABLE 18. MORTALITY RATES BY AGE 5 FOR ALL BIRTHS AND FOR LOW RISK BIRTHS FOR CALENDAR PERIODS

Country	Mortality rate for all births			Mortality rate for low risk births			Population attributable risk		
	Early 1970s	Late 1970s	Early 1980s	Early 1970s	Late 1970s	Early 1980s	Early 1970s	Late 1970s	Early 1980s
Bolivia	160	146	131	120	107	99	133	136	133
Brazil	116	108	79	69	71	46	168	152	173
Colombia	86	61	39	59	45	32	144	135	122
Dominican Republic	111	84	77	81	64	57	136	132	134
Ecuador	128	95	74	91	80	56	141	118	133
Guatemala	146	130	104	104	84	79	140	154	132
Mexico	85	72	54	60	54	41	142	135	132
Peru	136	117	102	98	76	73	138	154	141
Trinidad and Tobago	52	34	26	41	26	21	128	128	123
Egypt	193	163	102	112	91	62	172	179	164
Morocco	163	131	95	127	100	76	128	131	125
Tunisia	99	80	58	67	60	45	148	134	129
Botswana	86	58	50	67	49	47	127	119	107
Burundi	222	233	148	204	198	132	109	118	112
Ghana	178	145	145	158	118	131	112	122	111
Kenya	110	90	83	79	77	65	140	117	127
Liberia	265	233	214	197	175	189	134	133	113
Mali	355	305	246	275	215	184	129	142	134
Senegal	281	233	184	263	202	177	107	116	104
Togo	193	155	144	173	143	132	111	109	109
Uganda	179	199	177	119	156	150	150	127	118
Zimbabwe	90	100	69	73	77	57	123	130	121
Indonesia	134	123	96	100	101	85	134	122	112
Sri Lanka	54	47	32	45	40	30	122	118	106
Thailand	66	46	39	54	37	29	124	123	135
Mean 25 DHS							134	131	126

Sources: Demographic and Health Surveys individual recode files.

NOTE: "Low-risk" group comprises all well-spaced births and first births to 20-34-year-old mothers; "Intermediate-risk" group includes first and well-spaced subsequent births to teenage mothers and slow-paced poorly spaced births to 20-34-year-old mothers; "High-risk" group is composed of poorly spaced teenage births and poorly spaced medium and fast-paced births to 20-34-year-old mothers.

small improvement in the distribution of births is more than offset by a worsening of the excess risks, especially for the high-risk group. For Senegal, the distribution of births and the excess risks both worsened somewhat over time, leading to reinforcing contributions to an increase in the population attributable risk, albeit to a still low level.

It is also possible to compare time trends from within DHS, shown in tables 17 and 18, with WFS data shown in table 19. For Colombia, where the overlap of periods covered is five years, the story is remarkably consistent, indicating a steady improvement in the distribution of births and in the population attributable risks. For Peru, with an overlap of six years, the excess risk for the high-risk group steadily worsens, while the birth distribution gradually improves; this combination is consistent with the rise and subsequent fall in the population attributable risks. In Trinidad and Tobago, where smaller samples complicate interpretation and the overlap of experience is five years, the pattern of change in the birth distribution is one of consistent improvement, but the relative risks change inconsistently; since the major fertility decline occurred during the WFS period of observation, an improvement in the popu-

TABLE 19. COMPARISON OF DATA FROM WORLD FERTILITY SURVEY AND DEMOGRAPHIC HEALTH SURVEYS ON RELATIVE MORTALITY RISKS AND BIRTHS DISTRIBUTION FOR BROAD RISK GROUPS

Country	Mortality rate for low risk group	Relative risks			Birth distribution (per 1,000)			Population attributable risk
		Low risk	Intermediate risk	High risk	Low risk	Intermediate risk	High risk	
Colombia								
WFS	69	100	147	194	416	236	347	144
DHS	43	100	138	228	537	253	210	137
Peru								
WFS	120	100	136	196	502	218	279	135
DHS	81	100	142	251	545	228	227	144
Trinidad and Tobago								
WFS	34	100	121	210	459	235	307	139
DHS	28	100	146	186	551	259	190	128
Morocco								
WFS	104	100	154	206	503	198	299	142
DHS	98	100	152	187	575	201	224	130
Kenya								
WFS	114	100	140	167	476	242	282	129
DHS	72	100	138	180	532	234	233	127
Senegal								
WFS	256	100	104	109	609	242	151	102
DHS	203	100	116	133	576	249	175	110
Sri Lanka								
WFS	67	100	119	163	592	204	205	117
DHS	38	100	119	226	691	212	97	116
Thailand								
WFS	78	100	125	207	589	211	200	126
DHS	39	100	151	247	650	248	102	128
Mean								
WFS	106	100	130	181	518	223	259	128
DHS	76	100	136	204	582	236	182	127

Sources: Demographic and Health Surveys individual recode files and John Hobcraft, "Does family planning save children's lives?", Technical paper for the International Conference on Better Health for Women and Children through Family Planning, Nairobi, 5-9 October 1987.

NOTE: "Low-risk" group comprises all well-spaced births and first births to 20-34 year old mothers; "Intermediate-risk" group includes first and well-spaced subsequent births to teenage mothers and slow-paced poorly spaced births to 20-34-year-old mothers; "High-risk" group is composed of poorly spaced teenage births and poorly spaced medium and fast-paced births to 20-34-year-old mothers.

lation attributable risks may have occurred during the 1960s and early 1970s. In Kenya (overlap four years), the picture is one of steady, though slow, improvement in the distribution of births combined with somewhat erratic fluctuations in the relative risks; the population attributable risks are also inconsistent. The patterns for Senegal (overlap seven years) are puzzling: both the birth distribution and the relative risks appear to have worsened during the 1970s, only to improve again later; as a consequence, the population attributable risks also rise and fall. Internal analysis of WFS results for Senegal suggests that these trends are inconsistent, probably as a result of reporting errors in WFS. For Morocco, the birth distribution shows a steady improvement over time, with a reduction in the excess risks in the early 1970s, followed by some worsening; this produces the reduction in population attributable risks, followed by a plateau. Both Sri Lanka and Thailand experience massive reductions in the fraction of high-risk births, but show inconsistencies in the pattern of change for the relative risks between (and perhaps within) the two surveys, leading to fluctuations in the population attributable risks.

I. Conclusion

A detailed examination of tabular results from 25 DHS, and extensive comparison with both summary results and matching countries from WFS, has provided several opportunities to enhance understanding of the links between child-bearing patterns and infant and child mortality. The complexity of the relationships involved has been emphasized and some new empirical results on the impact of date imputation provided.

Teenage child-bearing, especially before age 18, is hazardous to the child (and to the mother, though this cannot be documented from DHS). The associations of early fertility (especially before age 18), and of short birth intervals with the chances of child survival are as strong 10 years on (using DHS data) as they were shown to be in earlier studies (based overwhelmingly on WFS). At the very least, policies which advocate delaying the first birth until a woman is at least 18 years of age might reduce the risk of death for first-born children by up to 20 per cent on average and up to 30 per cent in a few countries (e.g., Mexico, Peru, Dominican Republic and Egypt). However, the possible impact at the national level of a policy advocating delayed entry into motherhood on overall levels of child mortality is quite small, since teenage births are only a small fraction of all births.

Patterns of relative risk associated with various child-bearing patterns have been shown to be broadly the same, although some differences over time do emerge. The scope for policies advocating improved child-spacing to alter overall levels of child mortality is considerable. Children born at very short intervals after the preceding birth (one to 17 months) are about twice as likely to die as those born after intervals of 24-47 months; those born after 18-23 months experience an excess risk of about one third. Once again, it is clear that achieving adequate spacing between births might serve to reduce child mortality by up to 20 per cent or more in the countries of the Americas and Northern Africa. The scope for reduction is up to a third for Brazil and Egypt.

The analyses of time trends suggest that improvements in the timing of births over the life course of the mother are usually achieved with fertility reduction (at least broadly as a result of improved family planning), although an examination of direct ties to contraceptive behaviour have not been possible. The excess risks associated with poor timing of births (too early in the life course or too soon after the previous birth) do not seem to have altered significantly over time. Either public health programmes are failing to target this type of high-risk birth or interventions do not effectively ameliorate the excess risks. Since it is inevitable that some poorly timed births will occur, a better understanding of the mechanisms involved in creating the excess risks might help to target health programmes more effectively.

These results carry important messages for both health and family planning programmes. Since very early child-bearing and short birth intervals are so strongly associated with excess risks of death, it is important that programmes of ante-natal and post-natal care pay special attention to these high risk pregnancies and births. Although intervention would be much simpler if the mechanisms involved were known, ensuring basic levels of nutrition for the mother and the child might well help. There is an urgent need for research to clarify effective interventions. Health programmes should also encourage breast-feeding, since the health benefits to the child include both nutrition and the lengthening of birth intervals, both of which enhance survival chances.

The health rationale for family planning also emerges strongly from this study. Since there is little evidence of changes in the excess mortality associated with poor birth spacing or very early child-bearing over time or across societies at different levels of development, it is desirable that couples avoid having these high risk births. There is a clear message for women to avoid child-bearing in their teens, especially before age 18. It is even more important for the survival of their children that they try to ensure spacing of births at least two years apart. Even lengthening short inter-birth intervals

by a few months appears to convey a survival advantage to the child. Family planning programmes need to incorporate these elements into their information, education and communication in ways which help mothers to understand the excess risks of child death associated with births which are 'too early or too soon', without misleading them by overstating improved chances of survival. Family planning programmes should therefore encourage use of contraception for purposes of spacing births. This could save substantial numbers of children's lives.

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PART TWO

SOCIAL AND DEMOGRAPHIC FACTORS RELATED TO CHILD-SPACING AND CHILD MORTALITY: MULTIVARIATE ANALYSIS

A. Introduction

The first part of this report dwelt upon relatively simple tabular analyses. Such analyses have the advantage of being comprehensible, although digestion of quite simple tabulations for 25 countries is never easy. One potential problem with tabular analysis is that some of the apparent relationships may be spurious, being fully or partially accounted for by other factors. In order to protect against, but never fully remove, the over-interpretation of apparent relationships in simple tabulations, resort is commonly made to multivariate analysis as a means of controlling for the joint effects of several variables on outcomes of interest.

In this part of the report, the results of a series of five different multivariate analyses are presented for each of the 25 countries included in this study. The first three sets of models represent approximations to some of the models used in major comparative analyses of the experience covered by WFS programme (Hobcraft, McDonald and Rutstein, 1983, 1984, 1985). The results from these three models, since their publication, have been a keystone for assessing the correlates of child mortality and played an important role in documenting the health benefits of birth-spacing. This partial replication of earlier work makes it possible to update the earlier findings in a broadly comparable way and to assess whether relationships have altered significantly over time, albeit with provisos about overlap of time and space in the coverage. Two other main models are then considered, one for the experience of first births and one for the experience of second and higher-order births.

The first model used is a near replication of what is here called the "counts of births" model, which was first used in the pioneering comparative study on these issues (Hobcraft, McDonald and Rutstein, 1983). This model addressed the question as to whether the density of births in time segments preceding the birth of an index child was associated with excess risks of child death. The results demonstrated, for the first time on such an extensive scale, the powerful associations of child survival with the numbers of nearby earlier births. The model distinguished the associations of child survival with births in the two years preceding the index birth and the four years preceding that period. The analysis also addressed issues as to whether the associations were different for differing levels of mother's education, and also made an attempt to look at first births.

The second model considered here is close to the one used by Hobcraft, McDonald and Rutstein (1985) to consider further the "bio-demographic" correlates of child mortality for up to 39 WFS. This study broke new ground in considering the association of survival of the index child with the survival status of poorly-spaced preceding births and strongly suggested important clustering of child deaths within families. The study also included important new findings regarding the effects of poorly-spaced subsequent births on survival of the index child, which are not considered here.

The third model considered here covers the issues of the interplay among several socio-economic characteristics of child survival and almost replicates that used by Hobcraft, McDonald and Rutstein (1984). Although the socio-economic correlates of child mortality are by no means the major focus of this report, they are both of considerable importance in their own right, and relevant to the question as to how far observed associations of child mortality with the timing of births are attenuated by further controls.

The two new models represent an attempt to improve upon the models used in the earlier studies. Several problems arise from attempting to include first births and subsequent or "later" births in the same analysis. Many of the important correlates considered throughout this report are not defined for first births, since there is no preceding birth interval. This lack of information makes for considerable difficulty in interpretation. As a consequence, separate models are now fitted for first births, where the main issues of timing concern whether child-bearing begins "too early" and what the effects are for child survival. The final model considers only second and higher order (later) births and introduces a large range of controls for the timing and survival status of earlier births, several of which have not been used in comparative analysis before.

B. Data and methods

All of the multivariate analyses presented here have common features. In all cases, the dependent variable indicates whether or not the child in question (often referred to as the "index" child) survived to age two. The samples covered include all singleton births to women aged under 35 years at the time of the birth, during the period two to fifteen years before the surveys. These choices avoid censoring of experience, thereby making the model fitting simpler. Survival to age two covers most child mortality and elimination of only the births in the two most recent years minimizes the reduction in coverage. Multiple births are excluded (as in the tabular analysis) both because their mortality experience is much worse and because of the problems of defining many of the spacing variables for such births. No attempt is made to examine the relative importance of the covariates at different stages in the first two years of life. It is well known that socio-economic correlates of mortality show greater differentiation with increasing age of the child. The concern here is with assessing the overall impact on survival chances to age two for the various correlates of mortality. Moreover, presentation of detailed results from 25 countries with five different models is sufficiently complicated.

Fitting of the models has been carried out using the statistical software package STATA (Computing Resource Center, 1992) on data files derived for the tabular analysis. An appropriate model for the analysis of an indicator variable taking the values 0 and 1, depending upon the survival status of the child, is a logit or logistic model. The maximum likelihood procedure used to fit such models makes several assumptions. The assumed error distribution (binomial or Bernoulli) is predicated upon the sample being a simple random sample. Yet there is clustering of correlated responses at two levels: within the family, where each child experiences a similar or common socio-economic and health environment; and within the sampling unit or cluster, where each child experiences similar provision of health services and a similar disease environment (e.g., malaria or provision of piped water). A number of recent studies have used variance-components models to allow for the clustering of experience within families (Zenger, 1993; Curtis, McDonald and Diamond, 1993; Guo, 1993). Remarkably, these more elaborate studies suggest that the estimated impact of child-spacing variables on child survival alters very little as a result of controlling for clustering, although there is also clear evidence for familial effects which are not otherwise captured in the covariates used in typical models. In the light of these findings, the considerable extra complexity of variance components models was not pursued, since results appear to be fairly robust to these departures.

Before turning to the results, a few words are in order about assessing the relative importance of differing covariates. One important criterion is to check whether individual parameter estimates differ sufficiently from zero to be statistically significant. However, in view of the large number of parameter estimates considered here (the models contain 10-30 parameters for each of 25 countries), it is inevitable that chance errors in the determination of levels of statistical significance will occur. Nevertheless, the parameter estimates which appear to differ significantly from zero at both the 5 and 1 per cent levels are indicated, since this provides useful descriptive indications. An important advantage of fitting the same model to experience from 25 countries is that the consistency of results can be assessed. This is done formally using a sign test (see Siegel, 1956). For example, in the first model, the parameter estimates (shown in table 20) associated with the mother having had two births in the period two to six years before the birth of the index child are only statistically significant at the 1 per cent level for two out of 25 countries. However, 23 out of 25 of these parameter estimates are greater than zero; this would only occur about one in a hundred thousand times by chance, if there were no effect associated with this variable (and the experience of each country represented a chance outcome from the same distribution). Hence it is reasonable to make quite strong statements about there being consistent, though weak, excess mortality associated with this category of

TABLE 20. PARAMETER ESTIMATES, COUNTS-OF-BIRTH MODEL

Country	Total births	Constant	Earlier births 0-2 years[a]		Earlier births 2-6 years[b]			First births[c]	Mother's education[d] (in years)			One or more earlier births 0-2 years, mother's education 4+ years[e]
			1	2+	1	2	3+		1-3	4-6	7+	
Bolivia	12 321	-2.072	0.913[f]	1.685[f]	-0.053	0.125	0.526[f]	0.346[f]	-0.203[f]	-0.445[f]	-1.102[f]	-0.084
Brazil	7 823	-2.810	0.917[f]	1.985[f]	0.216	0.177	0.566[f]	0.699[f]	0.043	-0.393[f]	-1.010[f]	-0.036
Colombia	5 878	-2.805	0.820[f]	1.606[f]	0.093	0.103	0.369	0.456[s]	-0.425[f]	-0.914[f]	-1.249[f]	-0.016
Dominican Republic	10 325	-2.515	0.556[f]	1.147[f]	0.086	-0.071	0.092	0.491[f]	-0.243[s]	-0.533[f]	-0.915[f]	0.246
Ecuador	6 600	-2.131	0.645[f]	1.787[f]	-0.065	0.039	0.230	0.471[f]	-0.459[f]	-0.790[f]	-1.361[f]	-0.035
Guatemala	9 553	-2.555	0.987[f]	2.066[f]	-0.083	-0.016	0.249	0.780[f]	-0.198[s]	-0.399[f]	-1.315[f]	-0.111
Mexico	11 897	-2.629	0.773[f]	1.212[f]	-0.163	0.168	0.359[s]	0.317[s]	-0.316[f]	-0.618[f]	-1.036[f]	-0.192
Peru	7 035	-2.497	0.889[f]	1.964[f]	0.217	0.263	0.416[s]	0.616[f]	-0.146	-0.318[s]	-1.113[f]	-0.238
Trinidad and Tobago	4 114	-3.075	1.113[s]	2.148[f]	0.144	0.297	0.578	0.504	-0.677	-0.886	-0.723	-0.622
Egypt	18 180	-2.790	1.290[f]	2.166[f]	0.127	0.330[f]	0.673[f]	0.988[f]	-0.151[s]	-0.173[s]	-1.160[f]	-0.071
Morocco	12 935	-2.493	0.750[f]	1.603[f]	-0.062	0.070	0.222	0.574[f]	-0.305	-0.650[f]	-1.091[f]	0.119
Tunisia	8 950	-3.549	1.186[f]	2.541[f]	0.166	0.579[f]	0.714[f]	1.117[f]	-0.210	-0.419[f]	-0.837[f]	0.001
Botswana	6 373	-3.144	0.685[f]	0.754	0.142	0.456[s]	0.567	0.316	-0.176	-0.480[f]	-0.394[f]	0.343
Burundi	6 776	-2.260	0.683[f]	0.976[s]	0.017	0.101	0.403	0.371[s]	0.086	-0.040	-0.872[f]	-0.026
Ghana	7 416	-2.322	0.648[f]	0.627	0.019	0.074	-0.058	0.504[f]	-0.284	-0.006	-0.342[f]	-0.022
Kenya	14 074	-2.719	0.709[f]	1.307[f]	0.116	0.166	0.191	0.709[f]	-0.228[s]	-0.353[f]	-0.757[f]	-0.064
Liberia	9 192	-1.849	0.777[f]	1.271[f]	0.154	0.183	0.271[s]	0.600[f]	-0.032	-0.062	-0.343[f]	-0.354[s]
Mali	6 851	-2.225	1.099[f]	1.879[f]	0.088	0.120	0.534[f]	1.055[f]	-0.382[s]	-0.431[f]	-0.799[f]	-0.149
Senegal	8 247	-2.146	0.693[f]	0.939[f]	0.080	0.175	0.314	0.548[f]	-0.027	-0.660[f]	-0.953[f]	-0.118
Togo	5 724	-2.136	0.549[f]	-0.535	-0.290	0.103	0.289	0.194	-0.288	-0.397[f]	-0.753[f]	0.042
Uganda	8 762	-2.331	0.747[f]	1.228[f]	0.061	0.129	0.094	0.617[f]	0.180[s]	-0.015	-0.247[s]	-0.238
Zimbabwe	6 737	-2.979	0.731[f]	0.738	0.349	0.326	0.419	0.784[f]	0.080	-0.323[s]	-0.526[f]	0.059
Indonesia	20 782	-2.493	0.841[f]	1.528[f]	-0.015	0.178[s]	0.477[f]	0.448[f]	-0.068	-0.360[f]	-1.056[f]	-0.119
Sri Lanka	9 354	-3.230	0.746[f]	1.650[f]	0.345	0.267	0.472	0.564[f]	-0.203	-0.777[f]	-0.840[f]	0.122
Thailand	9 071	-3.244	0.658[s]	2.064[f]	-0.022	0.048	0.510	0.458[s]	0.180	-0.209	-0.903[f]	0.210
Americas	75 546	-2.565	0.846	1.733	0.044	0.121	0.376	0.520	-0.291	-0.589	-1.092	-0.121
Northern Africa	40 065	-2.944	1.075	2.103	0.077	0.326	0.537	0.893	-0.222	-0.414	-1.029	0.016
Sub-Saharan Africa	80 152	-2.411	0.732	0.918	0.074	0.184	0.302	0.570	-0.107	-0.277	-0.599	-0.053
Asia	39 212	-2.989	0.748	1.747	0.103	0.164	0.486	0.490	-0.030	-0.449	-0.933	0.071
Overall	234 970	-2.600	0.816	1.453	0.067	0.176	0.379	0.581	-0.178	-0.426	-0.868	-0.054

Sources: Demographic and Health Surveys individual recode files.
Note: Singleton births, born 2-15 years before the survey.
[a]Reference group: No births, 0-2 years before the survey.
[b]Reference group: No births, 2-6 years before the survey.
[c]Reference group: All later births.
[d]Reference group: No schooling.
[e]Interaction term.
[f]Significant at 1 per cent level.
[s]Significant at 5 per cent level.

births. In general, fewer than seven exceptions to a sign test (19 or more countries with the same sign) suggests a better than 1 per cent chance of the effect being significant. In the subsequent discussion the probability of an outcome in a simple sign test assuming independent observations is indicated; for example $p < 0.001$ means that this outcome might be expected to arise by chance in fewer than one in a thousand cases if there were no association.

The fitted models are all logistic or logit-linear models, which are fitted by maximum likelihood methods. The parameter estimates from such models can be interpreted as log odds. For example, for Bolivia in the first model (see table 20) the parameter estimate (or log odds) associated with one child having been born in the two years preceding the birth of the index child is 0.913. If this value is exponentiated, it gives an estimated odds ratio of

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2.492 (shown in table 21), meaning that an index child whose mother had one birth in the two years preceding its birth has odds of dying which are about 2.5 times that for an index child born more than two years after the preceding birth.

Beyond issues of statistical significance are those of substantive significance. To an extent, this can be assessed through examining the magnitude of the log odds or of the odds ratios. Where the odds are large (or small) there is evidence that big differences in mortality risks exist. However, a large excess risk may occur for a very small population group and thus be of little importance at the population level, while still highly significant for the few individuals at risk. In order to help in assessing the relative population importance of the factors considered here, a crude but effective "impact" score is introduced (which could also be termed the "population attributable log odds") derived from multiplying the parameter estimates (the log odds or measures of excess risk of death) by the proportions in the risk group

TABLE 21. ODD RATIOS, COUNTS-OF-BIRTH MODEL

Country	Total births	Earlier births 0-2 years[a]		Earlier births 2-6 years[b]			First births[c]	Mother's education[d] (in years)			One or more earlier births 0-2 years, mother's education 4+ years[e]
		1	2+	1	2	3+		1-3	4-6	7+	
Bolivia	12 321	2.492	5.394	0.948	1.133	1.691	1.413	0.816	0.641	0.332	0.919
Brazil	7 823	2.501	7.280	1.241	1.193	1.762	2.012	1.044	0.675	0.364	0.964
Colombia	5 878	2.270	4.981	1.097	1.109	1.446	1.578	0.654	0.401	0.287	0.985
Dominican Republic	10 325	1.744	3.147	1.090	0.931	1.096	1.634	0.784	0.587	0.401	1.280
Ecuador	6 600	1.906	5.972	0.937	1.039	1.259	1.602	0.632	0.454	0.256	0.966
Guatemala	9 553	2.683	7.892	0.921	0.984	1.283	2.181	0.820	0.671	0.268	0.895
Mexico	11 897	2.165	3.360	0.850	1.183	1.432	1.372	0.729	0.539	0.355	0.825
Peru	7 035	2.433	7.128	1.243	1.301	1.515	1.852	0.864	0.728	0.329	0.788
Trinidad and Tobago	4 114	3.044	8.563	1.155	1.346	1.782	1.655	0.508	0.412	0.486	0.537
Egypt	18 180	3.632	8.722	1.135	1.390	1.961	2.686	0.860	0.841	0.313	0.931
Morocco	12 935	2.117	4.969	0.940	1.073	1.249	1.775	0.737	0.522	0.336	1.127
Tunisia	8 950	3.272	12.688	1.180	1.785	2.043	3.055	0.811	0.658	0.433	1.001
Botswana	6 373	1.983	2.125	1.152	1.578	1.763	1.371	0.838	0.619	0.674	1.410
Burundi	6 776	1.979	2.655	1.017	1.106	1.496	1.449	1.090	0.961	0.418	0.974
Ghana	7 416	1.912	1.872	1.020	1.077	0.944	1.655	0.753	0.994	0.711	0.979
Kenya	14 074	2.033	3.693	1.123	1.181	1.211	2.032	0.796	0.702	0.469	0.938
Liberia	9 192	2.174	3.564	1.167	1.201	1.311	1.822	0.968	0.940	0.710	0.702
Mali	6 851	3.002	6.547	1.092	1.127	1.706	2.871	0.682	0.650	0.450	0.862
Senegal	8 247	1.999	2.558	1.083	1.192	1.369	1.730	0.973	0.517	0.386	0.888
Togo	5 724	1.732	0.586	0.748	1.109	1.335	1.214	0.749	0.672	0.471	1.043
Uganda	8 762	2.110	3.413	1.063	1.138	1.098	1.853	1.197	0.985	0.781	0.789
Zimbabwe	6 737	2.078	2.093	1.418	1.386	1.520	2.191	1.083	0.724	0.591	1.061
Indonesia	20 782	2.318	4.607	0.985	1.194	1.611	1.565	0.934	0.698	0.348	0.888
Sri Lanka	9 354	2.108	5.208	1.412	1.306	1.603	1.757	0.816	0.460	0.432	1.130
Thailand	9 071	1.930	7.881	0.978	1.049	1.665	1.581	1.197	0.811	0.406	1.234
Americas	75 546	2.330	5.659	1.045	1.128	1.457	1.682	0.747	0.555	0.336	0.886
Northern Africa	40 065	2.930	8.193	1.080	1.386	1.711	2.442	0.801	0.661	0.357	1.016
Sub-Saharan Africa	80 152	2.079	2.505	1.076	1.201	1.353	1.768	0.898	0.758	0.550	0.949
Asia	39 212	2.113	5.740	1.108	1.179	1.626	1.632	0.970	0.638	0.393	1.074
Overall	234 970	2.262	4.278	1.069	1.192	1.461	1.788	0.837	0.653	0.420	0.947

Sources: Demographic and Health Surveys individual recode files.
Note: Singleton births, born 2-15 years before the survey.
[a]Reference group: No births, 0-2 years before the survey.
[b]Reference group: No births, 2-6 years before the survey.
[c]Reference group: All later births.
[d]Reference group: No schooling.
[e]Interaction term.

(the fraction who experience the excess risk of death). For example, the parameter estimate (or log odds) associated with one child being born in the two years preceding the birth of the index child for Bolivia is 0.913 (table 20). The proportion of births occurring in this risk group for Bolivia is 29.2 per cent (table 22). The product of these two elements (0.913 times 0.292) is what is here termed as the "impact" score, or population attributable log odds; these values are shown in table 23. This simple measure of population impact can be summed across several risk groups (e.g., categories of education) in order to get a rough assessment of the population impact of a variable or even groups of variables on survival chances to age two. For example, for Bolivia, the two impact scores associated with counts of births in the two years preceding the index birth are 0.266 for one birth and 0.018 for two or more births (see table 23); the total impact for this variable is the sum of these two values, 0.285, and is shown in table 24. In very loose terms, these impact scores are sometimes taken to be equivalent to the logarithm of the overall

TABLE 22. PROPORTION OF BIRTHS IN EACH RISK GROUP, COUNTS-OF-BIRTH MODEL

Country	Total births	Earlier births 0-2 years[a]		Earlier births 2-6 years[b]			First births[c]	Mother's education[d] (in years)			One or more earlier births 0-2 years, mother's education 4+ years[e]
		1	2+	1	2	3+		1-3	4-6	7+	
Bolivia	12 321	0.292	0.011	0.309	0.241	0.061	0.243	0.291	0.209	0.275	0.133
Brazil	7 823	0.342	0.022	0.263	0.193	0.096	0.293	0.360	0.281	0.197	0.127
Colombia	5 878	0.301	0.008	0.284	0.186	0.055	0.309	0.372	0.292	0.215	0.129
Dominican Republic	10 325	0.339	0.017	0.286	0.246	0.075	0.247	0.365	0.281	0.232	0.165
Ecuador	6 600	0.315	0.017	0.294	0.227	0.066	0.259	0.245	0.375	0.253	0.189
Guatemala	9 553	0.284	0.010	0.323	0.266	0.055	0.230	0.238	0.135	0.058	0.048
Mexico	11 897	0.326	0.009	0.283	0.236	0.069	0.261	0.268	0.351	0.210	0.163
Peru	7 035	0.324	0.014	0.296	0.254	0.067	0.239	0.274	0.219	0.311	0.161
Trinidad and Tobago	4 114	0.295	0.007	0.276	0.149	0.041	0.330	0.050	0.339	0.597	0.279
Egypt	18 180	0.316	0.022	0.306	0.246	0.075	0.221	0.134	0.192	0.108	0.086
Morocco	12 935	0.307	0.016	0.284	0.299	0.082	0.212	0.032	0.064	0.040	0.028
Tunisia	8 950	0.322	0.010	0.283	0.261	0.063	0.243	0.075	0.216	0.095	0.095
Botswana	6 373	0.146	0.003	0.376	0.206	0.019	0.311	0.097	0.192	0.406	0.078
Burundi	6 776	0.237	0.006	0.338	0.282	0.042	0.245	0.080	0.107	0.043	0.040
Ghana	7 416	0.179	0.005	0.394	0.232	0.033	0.252	0.068	0.102	0.346	0.071
Kenya	14 074	0.280	0.010	0.320	0.308	0.059	0.207	0.095	0.211	0.353	0.152
Liberia	9 192	0.282	0.011	0.325	0.239	0.062	0.257	0.059	0.083	0.134	0.060
Mali	6 851	0.296	0.022	0.323	0.280	0.062	0.215	0.034	0.071	0.051	0.032
Senegal	8 247	0.221	0.005	0.326	0.317	0.042	0.232	0.026	0.079	0.047	0.029
Togo	5 724	0.177	0.006	0.389	0.268	0.027	0.242	0.080	0.133	0.062	0.025
Uganda	8 762	0.285	0.007	0.317	0.301	0.063	0.225	0.168	0.238	0.182	0.119
Zimbabwe	6 737	0.194	0.005	0.343	0.285	0.038	0.241	0.146	0.296	0.351	0.116
Indonesia	20 782	0.238	0.007	0.333	0.218	0.040	0.273	0.212	0.399	0.190	0.141
Sri Lanka	9 354	0.221	0.003	0.317	0.192	0.025	0.322	0.146	0.266	0.462	0.159
Thailand	9 071	0.209	0.006	0.301	0.158	0.024	0.356	0.051	0.698	0.159	0.178
Americas	75 546	0.313	0.013	0.291	0.222	0.065	0.268	0.274	0.276	0.261	0.155
Northern Africa	40 065	0.315	0.016	0.291	0.269	0.074	0.226	0.080	0.158	0.081	0.070
Sub-Saharan Africa	80 152	0.230	0.008	0.345	0.272	0.045	0.243	0.085	0.151	0.198	0.072
Asia	39 212	0.223	0.005	0.317	0.189	0.029	0.317	0.136	0.454	0.271	0.159
Overall	234 970	0.269	0.010	0.315	0.244	0.054	0.259	0.159	0.233	0.215	0.112

Sources: Demographic and Health Surveys individual recode files.
Note: Singleton births, born 2-15 years before the survey.
[a]Reference group: No births, 0-2 years before the survey.
[b]Reference group: No births, 2-6 years before the survey.
[c]Reference group: All later births.
[d]Reference group: No schooling.
[e]Interaction term.

reductions (or increases if the sign is negative) in mortality that might be achieved in the population if all children experienced the mortality risks of the reference group.

When the impact scores for mother's education are examined, two separate "total impact" scores are presented. For example, table 23 shows the population impact scores associated with differing levels of years of schooling, which are comparisons with a "no schooling" reference group. For example, for Bolivia, the sum of the three values is -0.455 (-0.059 -0.093 -0.303) and is shown in table 24. The population impact is thus a comparison with the group with the lowest survival chances and indicates the extent to which mortality levels are "better than they might be".

For almost all other variables, the reference group is taken to be the most advantaged group. In the case of mother's education, the most advantaged group has seven or more years of schooling, with a parameter estimate for Bolivia of -1.102. The total population impact score for mother's schooling (table 20) compared with this most advantaged group is derived by subtracting the parameter estimate from the earlier value of -0.455 to give 0.647, also shown in table 24.

TABLE 23. POPULATION ATTRIBUTABLE LOG ODDS, COUNTS-OF-BIRTH MODEL

Country	*Earlier births 0-2 years*[a]		*Earlier births 2-6 years*[b]			*First births*[c]	*Mother's education*[d] *(in years)*			*One or more earlier births 0-2 years, mother's education 4+ years*[e]
	1	*2+*	*1*	*2*	*3+*		*1-3*	*4-6*	*7+*	
Bolivia	0.266	0.018	-0.016	0.030	0.032	0.084	-0.059	-0.093	-0.303	-0.011
Brazil	0.314	0.044	0.057	0.034	0.054	0.205	0.015	-0.110	-0.199	-0.005
Colombia	0.247	0.012	0.026	0.019	0.020	0.141	-0.158	-0.267	-0.269	-0.002
Dominican Republic	0.189	0.020	0.025	-0.017	0.007	0.121	-0.089	-0.150	-0.213	0.041
Ecuador	0.203	0.031	-0.019	0.009	0.015	0.122	-0.112	-0.296	-0.344	-0.007
Guatemala	0.280	0.020	-0.027	-0.004	0.014	0.179	-0.047	-0.054	-0.076	-0.005
Mexico	0.252	0.012	-0.046	0.040	0.025	0.083	-0.085	-0.217	-0.217	-0.031
Peru	0.288	0.027	0.064	0.067	0.028	0.147	-0.040	-0.070	-0.346	-0.038
Trinidad and Tobago	0.329	0.014	0.040	0.044	0.023	0.166	-0.034	-0.300	-0.432	-0.173
Egypt	0.407	0.048	0.039	0.081	0.051	0.218	-0.020	-0.033	-0.125	-0.006
Morocco	0.231	0.025	-0.018	0.021	0.018	0.122	-0.010	-0.042	-0.043	0.003
Tunisia	0.382	0.025	0.047	0.151	0.045	0.271	-0.016	-0.091	-0.079	0.000
Botswana	0.100	0.003	0.053	0.094	0.011	0.098	-0.017	-0.092	-0.160	0.027
Burundi	0.162	0.006	0.006	0.028	0.017	0.091	0.007	-0.004	-0.038	-0.001
Ghana	0.116	0.003	0.008	0.017	-0.002	0.127	-0.019	-0.001	-0.118	-0.002
Kenya	0.199	0.014	0.037	0.051	0.011	0.147	-0.022	-0.074	-0.267	-0.010
Liberia	0.219	0.013	0.050	0.044	0.017	0.154	-0.002	-0.005	-0.046	-0.021
Mali	0.325	0.041	0.028	0.034	0.033	0.227	-0.013	-0.031	-0.041	-0.005
Senegal	0.153	0.005	0.026	0.056	0.013	0.127	-0.001	-0.052	-0.044	-0.003
Togo	0.097	-0.003	-0.113	0.028	0.008	0.047	-0.023	-0.053	-0.047	0.001
Uganda	0.212	0.009	0.019	0.039	0.006	0.139	0.030	-0.003	-0.045	-0.028
Zimbabwe	0.142	0.004	0.120	0.093	0.016	0.189	0.012	-0.096	-0.185	0.007
Indonesia	0.200	0.011	-0.005	0.039	0.019	0.122	-0.014	-0.144	-0.201	-0.017
Sri Lanka	0.165	0.005	0.109	0.051	0.012	0.182	-0.030	-0.207	-0.388	0.019
Thailand	0.138	0.012	-0.007	0.008	0.012	0.163	0.009	-0.146	-0.144	0.037
Americas	0.263	0.022	0.012	0.025	0.024	0.139	-0.068	-0.173	-0.267	-0.026
Northern Africa	0.340	0.033	0.023	0.084	0.038	0.204	-0.015	-0.055	-0.083	-0.001
Sub-Saharan Africa	0.172	0.009	0.023	0.048	0.013	0.135	-0.005	-0.041	-0.099	-0.004
Asia	0.168	0.009	0.033	0.033	0.014	0.156	-0.012	-0.166	-0.244	0.013
Overall	0.225	0.017	0.020	0.042	0.020	0.147	-0.029	-0.105	-0.175	-0.009

Sources: Demographic and Health Surveys individual recode files.
[a]Reference group: No birth, 0-2 years before the index child.
[b]Reference group: No birth, 2-6 years before the index child.
[c]Reference group: All later births.
[d]Reference group: No schooling.
[e]Interaction term.

TABLE 24. SUMMARY OF IMPACT SCORES, COUNTS-OF-BIRTH MODEL

Country	Earlier births 0-2 years[a]	Earlier births 2-6 years[b]	First births[c]	Mother's education[d]	Mother's education[e]
Bolivia	0.285	0.046	0.084	-0.455	0.647
Brazil	0.358	0.145	0.205	-0.294	0.716
Colombia	0.259	0.066	0.141	-0.694	0.555
Dominican Republic	0.208	0.014	0.121	-0.451	0.464
Ecuador	0.234	0.005	0.122	-0.753	0.608
Guatemala	0.300	-0.017	0.179	-0.177	1.138
Mexico	0.263	0.019	0.083	-0.519	0.517
Peru	0.315	0.159	0.147	-0.456	0.657
Trinidad and Tobago	0.343	0.108	0.166	-0.766	-0.043
Egypt	0.455	0.171	0.218	-0.179	0.982
Morocco	0.256	0.022	0.122	-0.095	0.997
Tunisia	0.407	0.243	0.271	-0.186	0.651
Botswana	0.103	0.158	0.098	-0.269	0.125
Burundi	0.168	0.051	0.091	-0.035	0.837
Ghana	0.119	0.023	0.127	-0.138	0.204
Kenya	0.212	0.100	0.147	-0.363	0.393
Liberia	0.232	0.111	0.154	-0.053	0.290
Mali	0.366	0.095	0.227	-0.085	0.715
Senegal	0.158	0.095	0.127	-0.098	0.855
Togo	0.094	-0.077	0.047	-0.123	0.630
Uganda	0.221	0.064	0.139	-0.018	0.229
Zimbabwe	0.146	0.229	0.189	-0.269	0.257
Indonesia	0.211	0.053	0.122	-0.359	0.697
Sri Lanka	0.170	0.172	0.182	-0.625	0.215
Thailand	0.150	0.013	0.163	-0.281	0.622
Americas	0.285	0.060	0.139	-0.507	0.584
Northern Africa	0.373	0.145	0.204	-0.153	0.877
Sub-Saharan Africa	0.182	0.085	0.135	-0.145	0.453
Asia	0.177	0.079	0.156	-0.421	0.511
Overall	0.241	0.083	0.147	-0.310	0.558

Sources: Demographic and Health Surveys individual recode files.
[a]Reference group: No births, 0-2 years before the survey.
[b]Reference group: No births, 2-6 years before the survey.
[c]Reference group: All later births.
[d]Reference group: No schooling.
[e]Reference group: Seven or more years of schooling.

C. THE COUNTS-OF-BIRTHS MODEL

The model

The earliest major comparative multivariate study of issues to do with the timing of nearby births was that of Hobcraft, McDonald and Rutstein (1983). The present adaptation of that study examines overall chances of survival to age two (rather than considering four age segments - neonatal, post-neonatal, toddler, and child) for singleton children born 2-15 years before the relevant surveys (not 5-15 years). Logit models are used here, which are more appropriate for probabilities than log-linear rate models.

The main idea behind this model is that the effects of nearby earlier births may be cumulative. The innovation of the 1983 study was to count the numbers of births occurring in segments of time prior to the birth of the index child (rather than using grouped interval lengths for the two preceding births, which leave ambiguity about the absolute timing of the

earlier of the pair and presents complications for low birth orders). The models examined here include the following variables: a count of the number of births in the two years preceding the index birth (0, 1, 2+); a count of the number of births in the period two to six years before the index birth (0, 1, 2, 3+); the years of schooling of the mother (0, 1-3, 4-6, 7+); an indicator variable for first births; and an interaction term between the presence of any birth in the two years preceding the index birth and a higher level (four or more years) of education for the mother. In essence these variables are similar to the ones used in the earlier study, although both the count for the period two to six years before the index child and the first birth indicator are properly defined here and thus improve upon the 1983 study; no allowance is made here for the possible impact of subsequent births, which was partially assessed for toddler and child mortality in the 1983 study.

Parameter estimates

The parameter estimates (log odds) resulting from fitting this common model to each of the 25 surveys are shown in table 20. Also shown are averages of the parameter estimates for the countries within each of four regional groupings and the overall average. The corresponding odds ratios are shown in table 21 and the proportions of children in each group are shown in table 22.

Preceding births

The occurrence of one or more births in the two years preceding the birth of the index child is associated with considerable excess mortality by age two for the index child, in comparison with the reference group where no birth occurred in the two years preceding the birth of the index child. The odds of a death by age 2 are more than doubled on average (2.262) if there is a single birth during this period and the effects are significant at the 1 per cent level in 23 of the 25 countries, with the other two being significant at the 5 per cent level. Parameter estimates for all countries exceed 0.5, meaning that the odds of death always exceed 1.6 to one, corresponding to an approximate 60 per cent excess odds of mortality. Where two or more births have occurred during the two years preceding the index birth, the excess mortality risks are generally higher still. The average parameter estimate corresponds to an odds ratio of 4.3. With the evidently strange exception of Togo, all the log odds estimates exceed 0.6 and are greater than 1.0 for all countries outside sub-Saharan Africa. Thus the excess mortality associated with births during the two years preceding the index birth is clear, substantial and pervasive.

Turning to the counts of births occurring in the period two to six years before the index birth, there is very little evidence of excess risks associated with a single birth (as compared with no birth), although a sign test suggests weak evidence for a slight excess risk (17 coefficients are positive; $p=0.054$). The estimated parameters for Sri Lanka and Zimbabwe are atypically large and that for Togo is aberrantly low, although none of these coefficients is statistically significant. Only a few of the individual country effects for two births during this period are statistically significant (four at 5 per cent), but 23 have a positive sign ($p<1$ in 100,000), strongly suggesting consistent, though generally weak, excess mortality for index children in this group. The average excess corresponds to an odds ratio of about 1.2 to 1. For the cases where three or more births occurred during this period, nine countries reach a 5 per cent significance level, but once again the overwhelming majority show excess mortality (24 out of 25; $p<1$ in 1,000,000). The average excess corresponds to an odds ratio of 1.46:1. Thus, the clustering of births two to six years before the index birth is associated with a persistent raising of mortality risks, although the magnitude of this increase is not large compared with the excess mortality where one or more children were born in the two years preceding the index birth.

First births

First births show a clear excess mortality, compared with the reference group of higher order births, with an overall average odds ratio of 1.79:1. However, since first births inevitably have counts of zero for the numbers of siblings born in the two and two to six years before their occurrence, their experience

is effectively being contrasted with that of later born children who do not have clustering of nearby births, and these excess risks are thus hard to interpret.

Mother's education

The association of survival to age two with the mother's level of schooling follows the expected patterns. One to three years of schooling on average reduces the odds of death to 0.84:1 compared with the no schooling group; the average for the four to six years group is 0.65:1; and for the seven or more years group is 0.42:1 (this last is of the same order of magnitude, but of opposite sign, to the average effect for a birth in the two years preceding the index birth). The extent of statistical significance increases with increasing education, with 4, 16, and 23 countries having effects which are significant at the one per cent level when compared with the no schooling group. But even one to three years of schooling for the mother usually lowers mortality risks by age two (20 countries have negative log odds, p=.002). The comparative advantage of having an educated mother seems smaller in many sub-Saharan African countries than elsewhere, for any level of schooling.

There is very weak evidence of an interaction of the effect of one or more births during the two years preceding the index birth with broad education level of the mother. The higher level of mother's education (four or more years of schooling) is associated with a reduced excess mortality for those index births with a closely preceding birth in 17 out of 25 countries (p=.054).

Population impact

Table 23 shows the population impact or population attributable log odds for all categories of the variables considered. For example, the first column refers to the impact of one birth occurring in the two years preceding the index birth and is derived by taking the product of the relevant parameter estimate from table 20 and the proportion of births in the relevant risk group from table 22. These impact scores are further summarized in table 24, which shows the totals of the impact scores across different categories of risk, derived by summing the relevant columns from table 23.

Preceding births

As would be expected from the tabular analysis, the overall impact of births within two years before the index birth (the first column of table 24) is lower for the Asian and sub-Saharan African countries, averaging about 0.18, roughly equivalent to a 20 per cent excess mortality in these populations. For the countries of the Americas the average impact is 0.285, or about a third excess mortality; and for the Northern African countries 0.373, about a 45 per cent excess. Mali is more like a Northern African country than Morocco in this respect.

The summary impact scores for births in the period two to six years before the index birth (in table 24) are generally lower, typically being around or below 0.1 (a value roughly equivalent to a 10 per cent population attributable excess mortality). Considerable variability is to be expected in these measures, since the individual parameter estimates were often fairly large, but not statistically significant, indicating a sizeable range of uncertainty. The high impact scores for Zimbabwe and Sri Lanka arise mainly from the unusually large parameter estimates for the one-child group. Egypt and Tunisia have significant proportions of children born to mothers who have had two or more births during the two to six years before the index birth, as a result of short birth intervals, and have high log odds for these risk groups, resulting in relatively big impact scores.

First births

About 20-30 per cent of the samples of index births considered here are first births. As already shown, first births experience considerable excess mortality risks, at least when compared with well-spaced later births. As a consequence, the impact scores for first births are fairly high, averaging 0.15, approximately a 16 per cent population attributable excess mortality. However, first births cannot be avoided.

Mother's education

In assessing the population impact associated with mother's education two questions can be posed: how far has the population come from the lowest possible education level and how much can still be gained from universal completion of seven or more years of education? Both these questions are posed as though the estimated education effects are entirely attributable to effects of mother's education, rather than arising partly through other correlated pathways; this is clearly not the case, but for simplicity of presentation these probably maximal impacts are discussed. Moreover, the contrasts of impact scores are derived from a cross-sectional analysis and all of the discussion is based upon contrasts of the current differentials. The gains "already achieved" or potential "room for improvement" are based upon the current situation; differentials may have been very different when no mother was educated and may be very different again when some secondary schooling is universal. For ease of presentation, these contrasts are sometimes loosely referred to as though time trends were implicit, but this is manifestly not the case.

The sum of the gains already made and the potential future gains inevitably equals the difference between the parameter estimates for the zero years and the seven or more years of schooling groups; as a consequence, the magnitude of this difference is important in looking at the overall results. As was shown above (table 20), the survival advantage of children born to mothers with seven or more years of schooling was typically smaller for the 10 sub-Saharan African countries.

This smaller differentiation by level of mother's education for the sub-Saharan countries is intriguing and cannot be simply accounted for. The four countries with especially low apparent differentiation in child survival by mother's education are Botswana, Ghana, Liberia and Uganda. Zimbabwe might be added to this list. Botswana, Ghana and Zimbabwe are unusual because over a third of all births were to mothers with seven or more years of schooling (Kenya is the only other sub-Saharan African country considered here which has this high a fraction of educated mothers, but it has slightly greater differentials). On the other hand, Liberia has fairly low educational levels, with nearly three quarters of all mothers having no schooling, although Liberia and Uganda are the only other two countries examined here where more than 10 per cent of mothers had received seven or more years of schooling. Botswana and Zimbabwe (again with Kenya) have achieved low levels of child mortality (fewer than 10 per cent of children in the tabular analysis died by age five); all other sub-Saharan countries in this study had child mortality in excess of 150 per 1,000. Liberia has the second highest child mortality of our 10 sub-Saharan countries.

How far have countries progressed as a result of maternal education? (More precisely, how does the current situation compare with the hypothetical case where all births occur to mothers with no schooling and experience the current mortality of those born to uneducated mothers, net of the other factors included in the model?) The impact scores are summarized in table 24. Compared with the hypothetical situation where all births are to uneducated mothers, the odds of death (derived very loosely by exponentiating the relevant impact score) by age two are more than halved in Trinidad and Tobago, Ecuador and Colombia and lower by more than a third in Sri Lanka, Mexico, Peru, Bolivia and Dominican Republic. Thus, among the countries of the Americas, the odds of dying by age two are reduced by a third or more in all but Brazil (25 per cent) and Guatemala (16 per cent), compared with a "no education" scenario. Sri Lanka is the only other country to have gains of this magnitude (46 per cent) from maternal education. Kenya, Indonesia, Thailand, Botswana and Zimbabwe have odds of death about 25 per cent lower than if all women were uneducated. The notional gains elsewhere are small, being less than 17 per cent in all African countries (except Kenya, Botswana and Zimbabwe) and in Guatemala.

How does the current situation compare with a hypothetical one where all births occur to mothers with seven or more years of schooling and experience the current net survival chances for such births? The population impact scores for mother's education compared with the high education group are shown in table 24. The scope for further child mortality reduction through achieving universal secondary edu-

cation is large in many countries. A population impact score of 0.69 or greater approximately indicates that the odds of child mortality are about twice as high as they might be if all children were born to mothers with secondary education. This is the case for Brazil, Colombia, Guatemala, Egypt, Morocco, Burundi, Mali, Senegal and Indonesia. Excess mortality of over two thirds (an impact score of 0.5 or greater) is also evident for Bolivia, Ecuador, Mexico, Peru, Tunisia, Togo and Thailand. Thus, for 16 of the 25 countries considered here, universal secondary education could lower the odds of child mortality by 0.60 to 1 (for the current situation) net of other controlled factors. The population impact scores for universal secondary education can be small (below 0.3) for two reasons: the differentiation in child survival by mother's schooling is small (e.g., for Uganda); or the female population is already well educated (e.g., Trinidad and Tobago).

What fraction of the "potential child survival gains" associated with maternal education have already been made? Answering this question requires dividing the total impact score compared with the no schooling group by the parameter estimate for the seven or more years of schooling group to obtain a fraction. Three countries appear well over half way to the maximal gain: Trinidad and Tobago is fully 95 per cent of the way; Sri Lanka three quarters; and, more surprisingly, Botswana two thirds of the way. A significant fraction of the countries are between 40 and 55 per cent of the maximum: all but Brazil and Guatemala in Latin America; and Ghana, Kenya and Zimbabwe in Africa. About a third of possible gains has been achieved in Brazil, Indonesia and Thailand. Otherwise the African countries (excepting the three mentioned above) and Guatemala have made little progress in this respect, with 16 per cent or less of the maximal gains, except for Tunisia at 22 per cent.

Differing family formation patterns

A further way of examining the implications of the results of this analysis is to follow the procedure used by Hobcraft, McDonald and Rutstein (1983) and "simulate" the mortality according to the fitted regression models for various combinations of spacing patterns. The results of this procedure are summarized in table 25, showing the estimated chances of death by age two for a child born to an uneducated mother for various combinations of spacing of births.[1] The baseline or reference category is the case where no birth occurred in the two years preceding the birth of the index child and one birth occurred in the four years before that denoted as (10.) in table 25, where the first figure is the number of births in the period two to six years before the index birth and the second refers to the count in the two years preceding that birth); this might be regarded as a fairly optimal spacing pattern for births.

In order to provide a succinct summary, the average value across all 25 countries is first discussed. For the reference group the overall average chance of death by age two is 78 per 1,000. A very poor spacing pattern in the period two to six years before the index birth, with three births in that period, but no further birth in the two years preceding the index birth (30.) is associated with an overall average chance of death by age two of 103 per 1,000, implying a relative risk of 135; or about a third excess mortality. For first births, where by definition no prior discriminating information on spacing is available, the overall average risk of death by age two is 124 per 1,000, with an excess mortality of 61 per cent. (Note that first births are here being contrasted with a relatively advantaged group of later births.)

The next two combinations (01.) and (11.) both imply a poorly spaced preceding birth, with one child having been born in the two years preceding the birth of the index child, but in one case there was no birth in the period two to six years before the index birth and in the other there was a single birth during that period. These combinations most likely correspond to a poorly spaced second birth and to poorly spaced third and higher order births respectively. Both the combinations are associated with somewhat similar excess mortality, with the overall average levels being 151 and 159 deaths by age two per 1,000 index births and an approximate doubling of mortality risk compared with the reference group.

The last two patterns examined correspond to very rare but extremely poor patterns of spacing of births (31.) and (02.). The first of these implies three

TABLE 25. ESTIMATED PROBABILITIES OF DEATH BY AGE TWO AND RELATIVE RISKS, COUNTS-OF-BIRTH MODEL

	Mortality rates (per 1,000)							*Relative risks (base = 100)*					
	Spacing patterns							*Spacing patterns*					
	10. (base)	*30.*	*First*	*01.*	*11.*	*31.*	*02.*	*30.*	*First*	*01.*	*11.*	*31.*	*02.*
Bolivia	107	176	151	239	229	347	405	165	142	224	215	325	379
Brazil	70	96	108	131	157	210	305	138	155	188	226	302	438
Colombia	62	81	87	121	131	166	232	129	140	194	210	266	372
Dominican Republic	81	81	117	124	133	134	203	101	144	153	165	165	250
Ecuador	100	130	160	185	175	222	415	130	160	184	175	221	414
Guatemala	67	91	145	172	161	211	380	136	217	258	241	316	569
Mexico	58	94	90	135	117	183	195	162	156	234	203	317	338
Peru	93	111	132	167	199	233	370	120	143	180	215	251	398
Trinidad and Tobago	51	76	71	123	140	200	283	150	140	243	276	396	560
Egypt	65	108	142	182	202	304	349	165	217	280	310	467	535
Morocco	72	94	128	149	141	179	291	130	178	207	196	249	404
Tunisia	33	55	81	86	100	161	267	169	246	262	305	491	815
Botswana	47	71	56	79	90	131	84	149	118	166	190	277	177
Burundi	96	135	131	171	174	236	217	141	137	178	181	246	226
Ghana	91	85	140	158	160	150	155	93	154	174	177	165	171
Kenya	69	74	118	118	131	140	196	107	171	171	190	203	284
Liberia	155	171	223	255	285	310	359	110	144	164	184	200	232
Mali	106	156	237	245	262	356	414	147	224	232	248	338	392
Senegal	112	138	168	189	202	242	230	123	150	168	180	216	205
Togo	81	136	125	170	133	215	65	168	154	209	163	264	80
Uganda	94	96	153	170	179	184	249	103	163	182	191	196	266
Zimbabwe	67	72	100	96	130	138	96	107	149	142	194	206	143
Indonesia	75	118	115	161	159	236	276	156	152	214	211	313	366
Sri Lanka	53	60	65	77	105	118	171	113	123	145	199	223	323
Thailand	37	61	58	70	69	111	235	166	158	191	187	303	640
Americas	76	104	118	155	160	212	310	137	155	207	214	284	413
Northern Africa	57	86	117	139	148	215	302	155	214	250	270	402	585
Sub-Saharan Africa	92	113	145	165	175	210	207	125	156	179	190	231	218
Asia	55	79	79	103	111	155	227	145	144	183	199	280	443
Overall	78	103	124	151	159	205	258	135	161	198	209	277	359

Source: Derived from table 20.

births in the two to four years before the index birth and a further birth in the remaining two years (such index births must be fifth or higher order births). The overall average probability of death by age two for this group is slightly over 200, with a near tripling of risk of death compared with the most advantaged group. The final pattern (02.) corresponds to either twins or two births in very rapid succession in the two years before the index birth and may well refer predominantly to extremely rapid third births, given that no other birth occurred in the four years preceding the burst of three births in two years. The overall average risk of death by age two for this pattern is just above 250 per 1,000 births, with mortality being about three and a half times that for the reference group.

The relative risks associated with poor child-spacing patterns in the few Northern African countries is greater than elsewhere. The only other evident regional pattern is that the excess mortality associated with the extreme risk groups appears to be

somewhat lower in sub-Saharan African countries, perhaps being suggestive of omissions of closely-spaced non-surviving children.

Comparison with WFS

How do these results compare with the 1983 study, based upon results from 26 countries included in WFS? There are minor differences between the two analyses, one being based on a log-linear regression model and the other using a logistic model with the definitions of some of the covariates slightly altered. The nearest basis for comparison with the earlier study is to compare DHS-based figures for survival to age two with the estimates for infant mortality in the WFS-based study. Taken overall, the results are remarkably similar, suggesting unaltered relationships over time. The relative risks for the (30.) group exceed 125 (a 25 per cent excess mortality) for 19 of 26 countries in the WFS-based study and in 16 of the 25 countries in the DHS-based study; eight countries in each study have an excess risk in excess of 50 per cent for this group. For first births the respective numbers of countries showing a 25 per cent excess risk are 24 and 23 (all but two in both cases), and 11 and 15 for a 50 per cent excess. For the (01.) group there is a 50 per cent excess mortality in all but two countries in both studies and mortality is more than doubled in 13 and 10 countries, respectively. The (11.) pattern also shows very similar results. Finally, the extreme (31.) pattern shows a doubling of risk in all but three countries and a tripling in 10 countries in both studies. The consistency of these differentials is really quite remarkable given that the time periods are different, there is a less than 50 per cent overlap in the countries considered and the geographical spread of the countries in the two studies differs, in addition to the methodological differences noted earlier.

D. The bio-demographic model

The model

The second set of regression models considered more or less replicate the analysis presented in Hobcraft, McDonald and Rutstein (1985), for up to 39 countries included in WFS. In that study, separate analyses were carried out for four age segments of under-five mortality; here the correlates of the chances of survival to age two are examined, without further differentiation by age. There are again some other small alterations from the earlier analysis. Births to teenage mothers are here further divided into those occurring before age 18 and those to 18- and 19-year-olds; for children born in the period two to four years before the index child the one child category is not subdivided by the survivorship status of that child, as was done in the 1985 study; otherwise the correlates and their categories are the same as in the earlier study.

Parameter estimates

Table 26 presents the parameter estimates from this model for each of the 25 DHS countries considered and the regional and overall averages of these parameter estimates (or log odds). The corresponding odds ratios are shown in table 27 and the proportions of births for each covariate are given in table 28.

Preceding births

Initially, the log odds associated with the counts of births in the two years before the index birth are examined. One poorly-spaced preceding child who survived at least until the birth of the index child is associated with very clear excess mortality. The parameter estimates are statistically significant at the 1 per cent level for 24 of the 25 countries and the remaining one is significant at the 5 per cent level. Even allowing for the correlated errors, such an occurrence is overwhelmingly unlikely to happen by chance. All but one of the log odds exceeds 0.5, corresponding to odds of death of more than 1.65 to one for this group compared with the reference group of index births with no sibling born in the preceding two years (the sign test for 24 out of 25 values exceeding a particular value suggest this would

TABLE 26. PARAMETER ESTIMATES, BIO-DEMOGRAPHIC MODEL

Country	Total births	Constant	Earlier births 0-2 years[a]: One alive	Earlier births 0-2 years[a]: One dead	Earlier births 0-2 years[a]: Two or more	Earlier births 2-4 years[b]: One	Earlier births 2-4 years[b]: Two or more	Birth order[c]: First	Birth order[c]: 4-6	Birth order[c]: 7+	Mother's age at birth[d]: <18	Mother's age at birth[d]: 18-19	Child's sex female[e]	Mother's education[f] (in years): 1-3	Mother's education[f] (in years): 4-6	Mother's education[f] (in years): 7+
Bolivia	12 321	-2.043	0.829[a]	1.168[a]	1.691[a]	0.141	0.633[a]	0.291[a]	-0.033	0.033	0.342[a]	0.230[b]	-0.200[a]	-0.224[a]	-0.510[a]	-1.142[a]
Brazil	7 823	-2.573	0.635[a]	1.672[a]	1.926[a]	0.222[b]	0.729[a]	0.390[a]	-0.175	0.003	0.772[a]	0.275[b]	-0.331[a]	-0.006	-0.434[a]	-0.957[a]
Colombia	5 878	-3.038	0.702[a]	1.528[a]	1.615[a]	0.293	0.425	0.425[b]	0.115	0.347	0.651[a]	0.086	-0.068	-0.358[b]	-0.824[a]	-1.086[a]
Dominican Republic	10 325	-2.536	0.544[a]	1.430[a]	1.282[a]	0.138	0.116	0.318[b]	-0.166	-0.035	0.401[a]	0.032	-0.175[b]	-0.217[b]	-0.371[a]	-0.716[a]
Ecuador	6 600	-2.173	0.597[a]	1.195[a]	1.878[a]	0.217	0.563[a]	0.519[a]	-0.108	-0.209	0.414[b]	-0.049	-0.230[b]	-0.447[a]	-0.803[a]	-1.352[a]
Guatemala	9 553	-2.631	0.873[a]	1.463[a]	2.078[a]	0.143	0.269	0.726[a]	-0.019	0.094	0.454[a]	0.216[b]	-0.220[a]	-0.187[b]	-0.402[a]	-1.247[a]
Mexico	11 897	-2.703	0.644[a]	0.889[a]	1.086[a]	0.154	0.454[a]	0.256	0.234[b]	0.116	0.624[a]	0.479[a]	-0.338[a]	-0.319[a]	-0.688[a]	-1.025[a]
Peru	7 035	-2.564	0.750[a]	1.437[a]	2.009[a]	0.461[a]	0.891[a]	0.516[a]	-0.090	-0.148	0.746[a]	0.242	-0.122	-0.162	-0.442[a]	-1.171[a]
Trinidad and Tobago	4 114	-2.946	0.504[b]	1.115[b]	1.468[b]	0.372	0.731	0.393	0.070	-0.342	0.750[a]	0.223	-0.086	-0.595	-1.130[b]	-0.942
Egypt	18 180	-2.876	1.180[a]	1.485[a]	2.128[a]	0.301[a]	0.637[a]	0.834[a]	0.027	0.160[b]	0.545[a]	0.205[a]	0.032	-0.151[b]	-0.173[a]	-1.053[a]
Morocco	12 935	-2.683	0.677[a]	1.243[a]	1.642[a]	0.239[a]	0.373[a]	0.596[a]	0.039	0.065	0.555[a]	0.281[a]	-0.099	-0.286	-0.555[a]	-0.943[a]
Tunisia	8 950	-3.490	1.066[a]	1.686[a]	2.457[a]	0.298[b]	0.845[a]	0.984[a]	0.121	0.142	0.908[a]	0.207	-0.082	-0.227	-0.405[a]	-0.800[a]
Botswana	6 373	-2.887	0.668[a]	1.398[a]	0.782	0.100	0.626[b]	0.092	0.061	-0.151	0.266	-0.131	-0.324[a]	-0.156	-0.376[b]	-0.309[b]
Burundi	6 776	-2.285	0.520[a]	1.093[a]	0.923[b]	0.160	0.256	0.329[b]	0.069	0.273	0.336	0.415[a]	-0.220[a]	0.088	-0.059	-0.822[a]
Ghana	7 416	-2.390	0.569[a]	0.902[a]	0.547	0.147	0.290	0.367[a]	0.015	-0.006	0.627[a]	0.117	-0.107	-0.284	-0.049	-0.320[a]
Kenya	14 074	-2.678	0.559[a]	1.658[a]	1.374[a]	0.298[a]	0.232	0.608[a]	-0.193[b]	0.013	0.266[b]	0.128	-0.150[b]	-0.231[b]	-0.395[a]	-0.772[a]
Liberia	9 192	-1.813	0.507[a]	1.299[a]	1.265[a]	0.369[a]	0.448[a]	0.445[a]	-0.153[b]	-0.118	0.486[a]	0.188[b]	-0.237[a]	-0.069	-0.246[b]	-0.505[a]
Mali	6 851	-2.384	1.056[a]	1.372[a]	1.964[a]	0.424[a]	0.575[a]	1.005[a]	-0.091	-0.145	0.420[a]	0.317[a]	-0.095	-0.414[b]	-0.508[a]	-0.815[a]
Senegal	8 247	-2.192	0.503[a]	1.047[a]	0.956[a]	0.221[b]	0.198	0.451[a]	0.065	0.033	0.376[a]	0.080	-0.132[b]	0.020	-0.630[a]	-0.887[a]
Togo	5 724	-2.386	0.461[a]	0.928[a]	-0.426	0.207	0.577[b]	0.352[b]	-0.178	0.102	-0.047	0.308[b]	0.021	-0.295	-0.372[a]	-0.748[a]
Uganda	8 762	-2.410	0.608[a]	1.226[a]	1.230[a]	0.303[a]	0.506[a]	0.541[a]	-0.024	-0.218	0.423[a]	0.208[b]	-0.140[b]	0.142	-0.115	-0.338[a]
Zimbabwe	6 737	-2.773	0.734[a]	0.909[a]	0.750	0.238	0.354	0.622[a]	0.020	0.284	0.179	0.111	-0.353[a]	0.076	-0.294[b]	-0.478[a]
Indonesia	20 782	-2.513	0.653[a]	1.332[a]	1.490[a]	0.239[a]	0.623[a]	0.384[a]	-0.015	0.188	0.533[a]	0.238[a]	-0.288[a]	-0.092	-0.399[a]	-1.006[a]
Sri Lanka	9 354	-2.964	0.732[a]	1.278[a]	1.690[a]	0.184	0.723[a]	0.417[b]	-0.058	-0.024	0.254	-0.107	-0.368[a]	-0.204	-0.719[a]	-0.788[a]
Thailand	9 071	-3.247	0.686[a]	1.252[a]	2.206[a]	0.010	-0.284	0.314	0.166	0.787	0.528[a]	0.464[a]	-0.399[a]	0.182	-0.079	-0.693[a]
Americas	75 546	-2.578	0.675	1.322	1.670	0.238	0.535	0.426	-0.019	-0.016	0.573	0.193	-0.197	-0.279	-0.623	-1.071
Northern Africa	40 065	-3.016	0.975	1.471	2.076	0.279	0.618	0.805	0.062	0.122	0.669	0.231	-0.050	-0.221	-0.378	-0.932
Sub-Saharan Africa	80 152	-2.420	0.618	1.183	0.936	0.247	0.406	0.481	-0.041	0.007	0.333	0.174	-0.174	-0.112	-0.304	-0.600
Asia	39 207	-2.908	0.691	1.287	1.795	0.144	0.354	0.372	0.031	0.317	0.438	0.198	-0.352	-0.038	-0.399	-0.829
Overall	234 970	-2.607	0.690	1.280	1.440	0.235	0.472	0.487	-0.012	0.050	0.472	0.191	-0.188	-0.177	-0.439	-0.837

Sources: Demographic and Health Surveys individual recode files.

NOTE: Singleton births born 2-15 years before the survey.

[a]Reference group: No births, 0-2 years before the index child.

[b]Reference group: No births, 2-4 years before the index child.

[c]Reference group: second or third order births.

[d]Reference group: Mother aged 20-34 years at birth.

[e]Reference group: Male children.

[f]Reference group: No schooling.

[g]Significant at 1 per cent level.

[h]Significant at 5 per cent level.

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TABLE 27. ODDS RATIOS, BIO-DEMOGRAPHIC MODEL

Country	Total births	Earlier births 0-2 years[a]: One alive	Earlier births 0-2 years[a]: One dead	Earlier births 0-2 years[a]: Two or more	Earlier births 2-4 years[b]: One	Earlier births 2-4 years[b]: Two or more	Birth order[c]: First	Birth order[c]: 4-6	Birth order[c]: 7+	Mother's age at birth[d]: <18	Mother's age at birth[d]: 18-19	Child's sex female[e]	Mother's education[f] (in years): 1-3	Mother's education[f] (in years): 4-6	Mother's education[f] (in years): 7+
Bolivia	12 321	2.291	3.215	5.426	1.152	1.884	1.337	0.967	1.033	1.408	1.259	0.818	0.799	0.600	0.319
Brazil	7 823	1.888	5.321	6.863	1.248	2.074	1.476	0.840	1.003	2.164	1.316	0.718	0.994	0.648	0.384
Colombia	5 878	2.017	4.608	5.029	1.341	1.529	1.529	1.122	1.415	1.917	1.090	0.935	0.699	0.439	0.338
Dominican Republic	10 325	1.723	4.179	3.603	1.148	1.123	1.374	0.847	0.966	1.494	1.033	0.839	0.805	0.690	0.489
Ecuador	6 600	1.816	3.304	6.542	1.243	1.756	1.680	0.898	0.811	1.513	0.952	0.795	0.640	0.448	0.259
Guatemala	9 553	2.393	4.319	7.992	1.154	1.309	2.067	0.982	1.098	1.574	1.241	0.802	0.830	0.669	0.287
Mexico	11 897	1.904	2.432	2.961	1.167	1.574	1.292	1.264	1.123	1.866	1.614	0.713	0.727	0.503	0.359
Peru	7 035	2.117	4.208	7.457	1.586	2.438	1.675	0.914	0.863	2.108	1.274	0.885	0.851	0.643	0.310
Trinidad and Tobago	4 114	1.655	3.051	4.341	1.451	2.077	1.482	1.072	0.710	2.117	1.250	0.918	0.552	0.323	0.390
Egypt	18 180	3.256	4.416	8.400	1.351	1.890	2.304	1.027	1.173	1.724	1.227	1.033	0.860	0.841	0.349
Morocco	12 935	1.969	3.465	5.167	1.271	1.451	1.815	1.040	1.067	1.742	1.324	0.906	0.751	0.574	0.390
Tunisia	8 950	2.904	5.398	11.668	1.347	2.328	2.675	1.128	1.153	2.480	1.230	0.921	0.797	0.667	0.449
Botswana	6 373	1.951	4.048	2.187	1.105	1.870	1.096	1.063	0.860	1.305	0.877	0.724	0.855	0.686	0.734
Burundi	6 776	1.682	2.984	2.517	1.173	1.292	1.390	1.071	1.314	1.399	1.514	0.803	1.092	0.943	0.439
Ghana	7 416	1.766	2.463	1.729	1.158	1.337	1.443	1.015	0.994	1.872	1.124	0.899	0.753	0.953	0.726
Kenya	14 074	1.749	5.248	3.949	1.347	1.261	1.836	0.824	1.013	1.305	1.136	0.861	0.794	0.674	0.462
Liberia	9 192	1.661	3.666	3.542	1.446	1.564	1.560	0.858	0.888	1.626	1.207	0.789	0.934	0.782	0.604
Mali	6 851	2.874	3.944	7.125	1.528	1.778	2.733	0.913	0.865	1.521	1.373	0.909	0.661	0.602	0.443
Senegal	8 247	1.654	2.849	2.600	1.248	1.219	1.570	1.067	1.033	1.456	1.084	0.876	1.020	0.533	0.412
Togo	5 724	1.586	2.529	0.653	1.230	1.781	1.422	0.837	1.107	0.954	1.361	1.021	0.745	0.689	0.473
Uganda	8 762	1.837	3.408	3.423	1.354	1.659	1.718	0.976	0.804	1.526	1.232	0.869	1.153	0.891	0.713
Zimbabwe	6 737	2.083	2.481	2.117	1.268	1.424	1.862	1.021	1.328	1.195	1.118	0.703	1.078	0.745	0.620
Indonesia	20 782	1.922	3.789	4.436	1.270	1.864	1.468	0.985	1.207	1.704	1.269	0.750	0.912	0.671	0.366
Sri Lanka	9 354	2.080	3.590	5.420	1.202	2.060	1.517	0.944	0.976	1.289	0.899	0.692	0.815	0.487	0.455
Thailand	9 071	1.986	3.496	9.083	1.010	0.753	1.369	1.181	2.196	1.695	1.590	0.671	1.200	0.924	0.500
Americas	75 546	1.964	3.750	5.314	1.269	1.707	1.531	0.981	0.984	1.773	1.213	0.821	0.756	0.536	0.343
Northern Africa	40 065	2.650	4.355	7.971	1.322	1.855	2.236	1.064	1.130	1.953	1.260	0.952	0.802	0.685	0.394
Sub-Saharan Africa	80 152	1.856	3.265	2.551	1.280	1.501	1.618	0.960	1.007	1.395	1.190	0.841	0.894	0.738	0.549
Asia	39 207	1.995	3.623	6.022	1.155	1.424	1.450	1.032	1.373	1.550	1.219	0.704	0.963	0.671	0.436
Overall	234 970	1.994	3.597	4.223	1.265	1.602	1.627	0.988	1.051	1.604	1.210	0.828	0.838	0.645	0.433

Sources: Demographic and Health Surveys individual recode files.

NOTE: Singleton births born 2-15 years before the survey.

[a]Reference group: No births, 0-2 years before the index child.

[b]Reference group: No births, 2-4 years before the index child.

[c]Reference group: second or third order births.

[d]Reference group: Mother aged 20-34 years at birth.

[e]Reference group: Male children.

[f]Reference group: No schooling.

TABLE 28. PROPORTION OF BIRTHS IN EACH RISK GROUPS, BIO-DEMOGRAPHIC MODEL

Country	Total births	Earlier births 0-2 years[a]: One alive	Earlier births 0-2 years[a]: One dead	Earlier births 0-2 years[a]: Two or more	Earlier births 2-4 years[b]: One	Earlier births 2-4 years[b]: Two or more	Birth order[c]: First	Birth order[c]: 4-6	Birth order[c]: 7+	Mother's age at birth[d]: <18	Mother's age at birth[d]: 18-19	Child's sex female[e]	Mother's education[f] (in years): 1-3	Mother's education[f] (in years): 4-6	Mother's education[f] (in years): 7+
Bolivia	12 321	0.239	0.052	0.011	0.417	0.066	0.243	0.288	0.081	0.077	0.102	0.489	0.291	0.209	0.275
Brazil	7 823	0.297	0.044	0.022	0.348	0.099	0.293	0.232	0.093	0.064	0.095	0.491	0.360	0.281	0.197
Colombia	5 878	0.277	0.023	0.008	0.345	0.055	0.309	0.227	0.072	0.088	0.115	0.481	0.372	0.292	0.215
Dominican Republic	10 325	0.308	0.031	0.017	0.397	0.083	0.247	0.281	0.116	0.112	0.125	0.488	0.365	0.281	0.232
Ecuador	6 600	0.276	0.038	0.017	0.385	0.079	0.259	0.263	0.086	0.079	0.120	0.483	0.245	0.375	0.253
Guatemala	9 553	0.236	0.047	0.010	0.451	0.063	0.230	0.306	0.076	0.099	0.122	0.486	0.238	0.135	0.058
Mexico	11 897	0.295	0.029	0.009	0.393	0.073	0.261	0.261	0.100	0.087	0.112	0.486	0.268	0.351	0.210
Peru	7 035	0.278	0.046	0.014	0.420	0.073	0.239	0.285	0.102	0.067	0.100	0.489	0.274	0.219	0.311
Trinidad and Tobago	4 114	0.280	0.015	0.007	0.307	0.047	0.330	0.200	0.045	0.079	0.128	0.487	0.050	0.339	0.597
Egypt	18 180	0.254	0.062	0.022	0.409	0.082	0.221	0.304	0.107	0.079	0.097	0.488	0.134	0.192	0.108
Morocco	12 935	0.254	0.053	0.016	0.469	0.088	0.212	0.324	0.115	0.059	0.092	0.485	0.032	0.064	0.040
Tunisia	8 950	0.288	0.034	0.010	0.424	0.070	0.243	0.295	0.071	0.013	0.057	0.500	0.075	0.216	0.095
Botswana	6 373	0.127	0.019	0.003	0.432	0.026	0.311	0.252	0.035	0.112	0.147	0.508	0.097	0.192	0.406
Burundi	6 776	0.178	0.058	0.006	0.498	0.052	0.245	0.301	0.061	0.045	0.090	0.490	0.080	0.107	0.043
Ghana	7 416	0.131	0.047	0.005	0.477	0.039	0.252	0.299	0.067	0.094	0.109	0.483	0.068	0.102	0.346
Kenya	14 074	0.251	0.029	0.010	0.486	0.066	0.207	0.332	0.115	0.113	0.119	0.502	0.095	0.211	0.353
Liberia	9 192	0.200	0.081	0.011	0.436	0.067	0.257	0.286	0.090	0.157	0.125	0.491	0.059	0.083	0.134
Mali	6 851	0.210	0.086	0.022	0.460	0.073	0.215	0.323	0.112	0.132	0.115	0.479	0.034	0.071	0.051
Senegal	8 247	0.151	0.070	0.005	0.533	0.050	0.232	0.313	0.095	0.134	0.119	0.489	0.026	0.079	0.047
Togo	5 724	0.122	0.055	0.006	0.509	0.039	0.242	0.317	0.069	0.109	0.117	0.485	0.080	0.133	0.062
Uganda	8 762	0.236	0.049	0.007	0.493	0.065	0.225	0.316	0.118	0.146	0.133	0.502	0.168	0.238	0.182
Zimbabwe	6 737	0.164	0.030	0.005	0.491	0.047	0.241	0.305	0.079	0.095	0.120	0.488	0.146	0.296	0.351
Indonesia	20 782	0.198	0.040	0.007	0.412	0.050	0.273	0.262	0.064	0.089	0.118	0.486	0.212	0.399	0.190
Sri Lanka	9 354	0.203	0.018	0.003	0.385	0.037	0.322	0.204	0.035	0.033	0.072	0.490	0.146	0.266	0.462
Thailand	9 071	0.188	0.021	0.006	0.332	0.033	0.356	0.181	0.028	0.054	0.102	0.489	0.051	0.698	0.159
Americas	75 546	0.276	0.036	0.013	0.385	0.071	0.268	0.260	0.086	0.084	0.113	0.487	0.274	0.276	0.261
Northern Africa	40 065	0.265	0.050	0.016	0.434	0.080	0.226	0.308	0.097	0.050	0.082	0.491	0.080	0.158	0.081
Sub-Saharan Africa	80 152	0.177	0.052	0.008	0.481	0.053	0.243	0.304	0.084	0.114	0.119	0.492	0.085	0.151	0.198
Asia	39 207	0.196	0.027	0.005	0.377	0.040	0.317	0.216	0.043	0.059	0.097	0.488	0.136	0.454	0.271
Overall	234 970	0.226	0.043	0.010	0.428	0.061	0.259	0.278	0.081	0.089	0.110	0.489	0.159	0.233	0.215

Sources: Demographic and Health Surveys individual recode files.

NOTE: Singleton births born 2-15 years before the survey.

[a]Reference group: No births, 0-2 years before the index child.

[b]Reference group: No births, 2-4 years before the index child.

[c]Reference group: second or third order births.

[d]Reference group: Mother aged 20-34 years at birth.

[e]Reference group: Male children.

[f]Reference group: No schooling.

happen with probability of less than one in a million). Togo has the only estimated log odds of less than 0.5, at 0.46. Three countries, Egypt, Tunisia and Mali, have parameter estimates exceeding 1.0 and correspond to odds of mortality by age two in excess of 2.7 to one compared with the reference group in these countries. These are consistent with the results presented in the tabular analysis and indicate that the deviant pattern observed for these three societies in terms of the greater excess mortality associated with poorly-spaced births is not an artefact of the other factors controlled here.

Although rarer, a sibling born in the two years before the index birth who fails to survive until the index birth is associated with considerably greater excess mortality. Hobcraft, McDonald and Rutstein (1985) provided strong circumstantial evidence that this greater excess mortality arose from the correlation of survival chances within families and operated in addition to the impact of the poor spacing. The substantial excess mortality is all-pervasive, being statistically significant at the 1 per cent level in all but one country and the lowest parameter estimate being 0.889 for Mexico, corresponding to an odds ratio of 2.43:1. The average odds ratio for all 25 countries is 3.6:1 for a child born after a short interval where the preceding child had already died, compared with the reference group of no birth in the preceding two years.

The parameter estimates associated with two or more births having occurred in the two years immediately before the index birth are more variable, mainly because this happens less often. Nevertheless, the estimates in 21 of the 25 countries are significant at the 5 per cent level and all but one exceed a value of 0.5. The only parameter estimates for this group which are below 1.0 (odds ratio less than 2.7:1) occur in sub-Saharan Africa (for 6 of the 10 countries), with the value for Togo being highly aberrant.

In summary, across the 25 countries considered in this analysis, the overall odds of death by age two are doubled by the occurrence of a birth in the two years before the index birth and increase a further 1.8 times (to 3.6) if this preceding child died before the index birth. Where two or more births occurred in these two years the odds of death are 4.2 to one, compared with the reference group with no births in the two years preceding the index birth.

As expected, the excess mortality associated with births occurring in the period two to four years before the index child is slight. For a single birth in this period, the average odds ratio of 1.26:1 partly reflects the lack of control for survival status of these children. Nevertheless, the parameter estimates are positive for all 25 countries, though not large and only reaching statistical significance at the 5 per cent level for 11 countries. Where two or more births occurred during the period of two to four years preceding the index birth the risks of death by age two were somewhat higher still, averaging odds of 1.6:1 and the parameter estimates were greater than zero for 24 of the 25 countries, being significant at the 5 per cent level for 15 of these. Moreover, the odds ratios for this group exceeded 1.5:1 for 16 of the 25 countries.

Birth order

Once again, first births show consistent excess mortality risks before age two with the log odds being positive for all 25 countries and exceeding 0.5 in 10 of these, and 21 countries having estimates which were statistically significant at the 5 per cent level. It is important to note that these excess risks are effectively contrasted with the mortality for well-spaced later births, since the number of preceding births for a first birth is, of course, zero. Otherwise, the association of survival chances with birth order is extremely weak in almost all countries.

Early child-bearing

There is a clear excess risk of child mortality associated with the mother being under age 18 at the time of the birth: the average odds are 1.6:1, all but one of the log odds estimates are positive ($p < 0.000001$), 11 exceed 0.5, and 20 reach a 5 per cent level of significance. The deleterious effects of motherhood in the later teens (18-19) are weaker but

nevertheless persistent: 22 of the parameter estimates are positive ($p=0.00008$) and 13 are significant at the 5 per cent level.

Sex differentials

Daughters nearly always experience lower mortality up to age two, with the log odds being negative for all but two countries (Egypt and Togo) and being significantly different from zero at the 5 per cent level for 16 of the 25 countries. The sex difference in survival chances to age two is weak in several countries (the log odds being smaller than -0.1 in Colombia, Trinidad and Tobago, Morocco, Tunisia and Mali, in addition to being above zero for Egypt and Togo). On the other hand, sex differences are quite large (with a reduction of 25 per cent or more for girls compared with boys in the odds ratios for death before age two) in Brazil, Mexico, Botswana, Zimbabwe, Indonesia, Sri Lanka and Thailand.

Mother's education

The estimated effects of the mother's level of education, included largely as a control, are similar to those for the preceding counts of births model. Schooling of one to three years is associated with a small average reduction in mortality risks for the index child; fully 20 of the 25 countries have negative parameter estimates ($p=$ [illegible]), but only a few are large enough to be individually statistically significant (9 at 5 per cent). When the mother has four to six years of schooling the parameter estimates (log odds) are negative for all 25 countries and 21 of these are significant at the 5 per cent level; in 9 countries these log odds fall below -0.5, corresponding to about a 40 per cent reduction in mortality. Seven or more years of schooling for the mother is again universally associated with a reduction in mortality risks for the child up to age two, with 21 of the 25 countries now having log odds estimates below -0.5, and 24 being statistically significant at the 5 per cent level and all but one of these also at the 1 per cent level. There is once again considerable regional patterns in the results, with the log odds for the children of mothers in the highest education group being below -0.6 for all countries outside sub-Saharan Africa, but only below -0.6 for 5 of the 10 countries in that region (the exceptions being Botswana, Ghana, Uganda, Zimbabwe, and Liberia). Indeed, the contrast between the 10 sub-Saharan African countries and the 9 countries of the Americas is quite sharp: the parameter estimates associated with the mother having had seven or more years of schooling are higher (nearer to zero) for every sub-Saharan African country than for 8 of the 9 American countries, with the Dominican Republic proving the one exception.

Population impact

Preceding births

Table 29 provides estimates of the "impact" at the population level (the population attributable log odds) for the main groups of covariates considered in this series of models. The sums of these impact scores across all categories for each covariate are shown in table 30. These summary impact scores for the covariates associated with births in the two years preceding the birth of the index child are very similar to those presented in table 24 for the counts-of-births model. The subdivision of the one-birth category by survival status of the preceding birth and the somewhat different other controls make little difference to the overall assessment of the impact of poor birth spacing. The average impact score for the 25 countries is 0.230, corresponding to about a 26 per cent increase in overall odds of death associated with these births (or a 26 per cent "excess mortality" in looser terms). As might be expected from all the foregoing analyses, these excesses are highest for the Northern African countries, averaging 45 per cent (and Mali is more Northern African in this respect than Morocco), are also high in the countries of the Americas (average excess of 29 per cent), and are lower in the sub-Saharan African and Asian countries where the average excess mortality is about 20 per cent.

Excess mortality associated with births in the period two to four years before the index child is generally lower than for the shorter preceding interval, but perhaps higher than might be expected. The average overall impact score is 0.131, or a 14 per

TABLE 29. POPULATION ATTRIBUTABLE LOG ODDS, BIO-DEMOGRAPHIC MODEL

Country	Earlier births 0-2 years[a]			Earlier births 2-4 years[b]		Birth order[c]			Mother's age at birth[d]		Child's sex	Mother's education[e] (in years)		
	One alive	One dead	Two or more	One	Two or more	First	4-6	7+	<18	18-19	female[f]	1-3	4-6	7+
Bolivia	0.198	0.061	0.019	0.059	0.042	0.071	-0.010	0.003	0.026	0.023	-0.098	-0.065	-0.107	-0.314
Brazil	0.189	0.073	0.043	0.077	0.072	0.114	-0.040	0.000	0.050	0.026	-0.162	-0.002	-0.122	-0.189
Colombia	0.194	0.036	0.012	0.101	0.023	0.131	0.026	0.025	0.057	0.010	-0.033	-0.133	-0.241	-0.234
Dominican Republic	0.167	0.044	0.022	0.055	0.010	0.078	-0.047	-0.004	0.045	0.004	-0.086	-0.079	-0.104	-0.166
Ecuador	0.165	0.046	0.032	0.084	0.045	0.134	-0.028	-0.018	0.033	-0.006	-0.111	-0.109	-0.301	-0.342
Guatemala	0.206	0.069	0.020	0.065	0.017	0.167	-0.006	0.007	0.045	0.026	-0.107	-0.044	-0.054	-0.072
Mexico	0.190	0.026	0.010	0.061	0.033	0.067	0.061	0.012	0.054	0.054	-0.164	-0.086	-0.242	-0.215
Peru	0.209	0.066	0.027	0.194	0.065	0.123	-0.026	-0.015	0.050	0.024	-0.060	-0.044	-0.097	-0.364
Trinidad and Tobago	0.141	0.017	0.010	0.115	0.035	0.130	0.014	-0.015	0.059	0.029	-0.042	-0.030	-0.383	-0.563
Egypt	0.299	0.092	0.048	0.123	0.052	0.185	0.008	0.017	0.043	0.020	0.016	-0.020	-0.033	-0.113
Morocco	0.172	0.066	0.026	0.112	0.033	0.127	0.013	0.007	0.033	0.026	-0.048	-0.009	-0.036	-0.037
Tunisia	0.307	0.058	0.024	0.126	0.059	0.239	0.036	0.010	0.012	0.012	-0.041	-0.017	-0.088	-0.076
Botswana	0.085	0.027	0.003	0.043	0.016	0.029	0.015	-0.005	0.030	-0.019	-0.164	-0.015	-0.072	-0.126
Burundi	0.093	0.064	0.005	0.080	0.013	0.080	0.021	0.017	0.015	0.037	-0.108	0.007	-0.006	-0.035
Ghana	0.075	0.043	0.003	0.070	0.011	0.092	0.004	0.000	0.059	0.013	-0.052	-0.019	-0.005	-0.111
Kenya	0.140	0.048	0.014	0.145	0.015	0.126	-0.064	0.001	0.030	0.015	-0.075	-0.022	-0.083	-0.273
Liberia	0.102	0.105	0.013	0.161	0.030	0.114	-0.044	-0.011	0.076	0.024	-0.116	-0.004	-0.021	-0.068
Mali	0.222	0.118	0.043	0.195	0.042	0.216	-0.029	-0.016	0.055	0.036	-0.046	-0.014	-0.036	-0.042
Senegal	0.076	0.073	0.005	0.118	0.010	0.105	0.020	0.003	0.050	0.010	-0.065	0.001	-0.050	-0.041
Togo	0.056	0.051	-0.003	0.105	0.023	0.085	-0.056	0.007	-0.005	0.036	0.010	-0.024	-0.049	-0.047
Uganda	0.143	0.060	0.009	0.150	0.033	0.122	-0.008	-0.026	0.062	0.028	-0.070	0.024	-0.027	-0.061
Zimbabwe	0.120	0.027	0.004	0.117	0.017	0.150	0.006	0.022	0.017	0.013	-0.172	0.011	-0.087	-0.168
Indonesia	0.129	0.053	0.011	0.098	0.031	0.105	-0.004	0.012	0.048	0.028	-0.140	-0.019	-0.159	-0.191
Sri Lanka	0.148	0.023	0.005	0.071	0.027	0.134	-0.012	-0.001	0.008	-0.008	-0.180	-0.030	-0.191	-0.365
Thailand	0.129	0.027	0.012	0.003	-0.009	0.112	0.030	0.022	0.029	0.047	-0.195	0.009	-0.055	-0.111
Americas	0.184	0.049	0.022	0.090	0.038	0.113	-0.006	-0.001	0.047	0.021	-0.096	-0.066	-0.183	-0.273
Northern Africa	0.259	0.072	0.032	0.121	0.048	0.183	0.019	0.012	0.029	0.019	-0.024	-0.015	-0.052	-0.076
Sub-Saharan Africa	0.111	0.061	0.010	0.118	0.021	0.112	-0.013	-0.001	0.039	0.019	-0.086	-0.006	-0.044	-0.097
Asia	0.136	0.034	0.009	0.058	0.016	0.117	0.005	0.011	0.028	0.023	-0.172	-0.013	-0.135	-0.222
Overall	0.158	0.055	0.017	0.101	0.030	0.121	-0.005	0.002	0.039	0.020	-0.092	-0.029	-0.106	-0.173

Sources: Demographic and Health Surveys individual recode files.

[a]Reference group: No births, 0-2 years before the index child.

[b]Reference group: No births, 2-4 years before the index child.

[c]Reference group: second or third order births.

[d]Reference group: Mother aged 20-34 years at birth.

[e]Reference group: Male children.

[f]Reference group: No schooling.

cent excess, with the values being typically a little higher in the Northern African countries and somewhat lower for the Asian countries. Since spacing of births at intervals of two to four years is widely advocated as desirable, this apparent excess could be a possible source of concern. The excess arises from a large fraction of the population being in this risk group combined with only moderate excess mortality risks. As mentioned earlier, the small excess risk compared to reference groups arises partly from there being no control for the survival status of the births. But perhaps more important is that an index child which is in the reference group for both the count of births in the two years preceding and in the period two to four years before is either a first-born child (with identified higher risk) or is born after a long inter-birth interval (of more than four years). As was shown in the tabular analysis, very long preceding birth intervals are associated with apparent low risks of death for the index child. This feature seems to occur with retrospective birth histories, having also been apparent for analyses of the results from WFS. One highly probable explanation concerns the possible omission of dead children from

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TABLE 30. SUMMARY OF IMPACT SCORES, BIO-DEMOGRAPHIC MODEL

Country	*Earlier births 0-2 years*[a]	*Earlier births 2-4 years*[b]	*Mother's age at birth < 20*[c]	*Mother's education*[d]
Bolivia	0.278	0.101	0.050	0.656
Brazil	0.305	0.149	0.076	0.644
Colombia	0.243	0.124	0.067	0.478
Dominican Republic	0.234	0.064	0.049	0.366
Ecuador	0.243	0.128	0.027	0.599
Guatemala	0.296	0.082	0.071	1.076
Mexico	0.226	0.094	0.108	0.483
Peru	0.302	0.259	0.074	0.665
Trinidad and Tobago	0.168	0.149	0.088	-0.034
Egypt	0.439	0.175	0.063	0.886
Morocco	0.264	0.145	0.058	0.861
Tunisia	0.389	0.186	0.024	0.620
Botswana	0.114	0.060	0.011	0.096
Burundi	0.162	0.093	0.052	0.787
Ghana	0.120	0.081	0.072	0.185
Kenya	0.202	0.160	0.045	0.394
Liberia	0.219	0.191	0.100	0.412
Mali	0.383	0.237	0.092	0.723
Senegal	0.154	0.128	0.060	0.797
Togo	0.104	0.128	0.031	0.628
Uganda	0.212	0.183	0.089	0.273
Zimbabwe	0.151	0.134	0.030	0.234
Indonesia	0.194	0.130	0.076	0.636
Sri Lanka	0.177	0.098	0.001	0.203
Thailand	0.168	-0.006	0.076	0.537
Americas	0.255	0.128	0.068	0.548
Northern Africa	0.364	0.169	0.048	0.789
Sub-Saharan Africa	0.182	0.139	0.058	0.453
Asia	0.180	0.074	0.051	0.458
Overall	0.230	0.131	0.060	0.528

Sources: Demographic and Health Surveys individual recode files.
[a]Reference group: No births, 0-2 years before the index child.
[b]Reference group: No births, 2-4 years before the index child.
[c]Reference group: Mother aged 20-34 years at birth.
[d]Reference group: Seven or more years of schooling.

the retrospectively reported maternity histories, which would lead to spuriously long inter-birth intervals and associated apparent improvements in survival chances. A further possibility, which may also be plausible in more advanced societies with increasing fertility control is that some longer intervals represent contraceptive failures and occur in families that are more modern or of higher socio-economic status, with associated improved chances for child survival.

Birth order

First births show an average population impact of 0.121, or about a 13 per cent overall excess mortality at the population level. This is partly an artefact of the particular reference groups used for the analysis and only the timing of first births is amenable to demographic policy intervention. Any excess mortality risks for first births over and above the impact

of teenage motherhood must be combated through medical interventions to lower the risk, since any mother must have a first birth. The population impact of high order births is extremely small, as would be expected from the very small effects (log odds) presented in table 26.

Early child-bearing

Although early child-bearing, especially before age 18, carries considerably increased mortality risks for the child, the population impact of having children "too young" is inevitably small, since the proportion of all births which occur to teenage mothers is low in most countries. The average excess mortality at the population level arising from teenage motherhood is about 6 per cent, with little evident regional patterning.

Mother's education

Since the role of mother's education is not a central concern of this study and the total impact, both of how far the countries have come and how far they have to go, is very similar to that discussed at some length under the "counts-of-births models", the results presented in tables 29 and 30 are not considered further here.

Comparison with WFS

Before leaving the bio-demographic model it is worth comparing the results, as far as possible, with those of the similar model used for comparative analysis of WFS data by Hobcraft, McDonald and Rutstein (1985). As mentioned earlier, there are differences between the models used in that study and the one presented here. Only the overall chances of survival to age two have been examined here, instead of neonatal, post-neonatal, toddler, and later child mortality. This study uses logistic models and presents log odds and odds ratios, whereas the 1985 study used log-linear models and presented relative risks; the two measures (odds ratios and relative risks) are not strictly comparable and any equivalencing varies with the overall level of mortality (see Altman, 1991). There are minor differences in the covariates used. Moreover, any comparisons made will partly reflect variation over time, since DHS occur about 5-10 years later than WFS, but may also reflect the different country coverage, with 13 countries being included in both studies (and Dominican Republic partially so); Asian countries are far less well represented in the more recent study. As a consequence of these differences between the two studies, comparisons will inevitably be a little looser than is ideal, although the similarities are much greater than is usually the case for such comparisons.

Both studies show a tendency for girls to be disadvantaged (compared with their almost certain biological advantage) in the Arab world; the WFS study showed similar apparent discrimination against girls in Bangladesh, Nepal and Pakistan. Both studies show clear excess mortality for children born to teenage mothers and the later one confirms that these risks are greater where the mother is under age 18. Both studies show a clear excess mortality for first births, with the earlier study indicating that the differences reduce with increasing age of the child.

Neither study suggests any clear excess mortality associated with higher birth orders, once the effects of other covariates are controlled. Hence, the frequent policy prescription of avoiding "too many" births appears to have no evident justification in terms of the survival chances of the child, but rather to derive from a societal or health of the mother perspective. Similarly, bearing children "too old" (beyond age 35) is often prescribed as undesirable on grounds of the health of the child. These studies contain very little evidence on this issue since the DHS study excludes children born to mothers aged 35 and over for methodological reasons. The WFS study, although affected by truncation, found no evidence of strong survival disadvantages for children born to older mothers.

Both studies found strong and pervasive increases in mortality risks for children born "too soon" after the preceding birth (sometimes "too close"). Where the preceding child was still alive, the excess mortality was typically of the order of mortality risks being 70-100 per cent higher. Evidence of a poor health

background, through the failure of the preceding child to survive, raised these risks of death by about a further 80 per cent. The association of higher mortality risks with short preceding birth intervals was higher in the Northern African (and Western Asian for the WFS study) countries. Moreover, the fraction of all births occurring in the high risk groups means that it is possible that policies to lengthen birth intervals or equivalently to reduce the fraction of short intervals could improve the survival chances of children. Thus a policy prescription of helping couples to avoid closely-spaced births seems warranted on grounds of the health of the children. It is also noted that the WFS study showed the increased risk for the survival chances of the earlier birth of a pair of closely-spaced births.

E. The socio-economic model

The model

The third set of models that have been fitted for all 25 DHS countries included in this study contain several socio-economic covariates, but none of the bio-demographic ones and almost replicate the earlier study, based on WFS results, of Hobcraft, McDonald and Rutstein (1984). The variables considered include the mother's and her current or most recent husband's level of education (years of schooling, categorized as 0, 1-3, 4-6, and 7 or more years), the husband's broad occupational grouping (classified as agriculture, skilled and unskilled manual, sales and service, and professional and clerical), and the geographical regions of current residence identified for each of the countries (ranging in number from zero in Botswana to ten for Zimbabwe), which are shown in table 31. There were difficulties in achieving standardized categorizations for the husband's characteristics in several of the DHS, with the information on the standard individual recode files proving unusable in several instances. Thus, it was not possible to include the current or most recent husband's occupation grouping for Mexico, Egypt, Liberia and Togo. Moreover, the information on husband's education was not useable for Mexico. There are further problems entailed in this analysis, both because the current or most recent husband may not have been the father of all of the mother's children and since values are missing for never-married women. Furthermore, all of the socio-economic variables considered here represent the circumstances at the time of the survey (or perhaps the time of separation for characteristics of past husbands). As a consequence the results presented may be distorted by past social or geographic mobility.

Parameter estimates

The parameter estimates for this model are presented in table 32, the odds ratios are shown in table 33 and the sample distribution of births is given in table 34. Taken overall, the effects of level of maternal education upon child survival seem stronger than the level of the husband's education. The strength of association with husband's level of education is weaker than for mother's educational level for the gross effects in each of the broad continental groupings used throughout this study. Moreover, when the other socio-economic factors are controlled, the associations with husband's level of education attenuate considerably, as do those with his occupation.[2] Thus mother's schooling is generally more strongly associated with child survival than the husband's characteristics and the net influence of husband's characteristics is also attenuated much more by control for other covariates.

Mother's education

Turning to the results presented in table 32, the clear and pervasive role of mother's education is evident for child survival. Where the mother has only one to three years of schooling the advantages for child survival are small, compared with the reference group of uneducated mothers, and only reach a 5 per cent significance level for five countries. However, the log odds are negative for 20 of the 25 countries, suggesting that apparent advantages are real ($p=0.002$). The five exceptions are Burundi, Senegal, Uganda, Zimbabwe and Thailand. The overall average gain in survival chances associated with the mother having received one to

TABLE 31. DEFINITIONS OF REGIONS

Bolivia	1 Altiplano; 2 Valles; 3 Llanos.
Brazil	1 Rio de Janerio; 2 São Paulo; 3 South; 4 Central/Southeast; 5 Northeast; 6 North.
Colombia	1 Atlantica; 2 Pacifica; 3 Central; 4 Oriental; 5 Bogota.
Dominican Republic	1 Distrito Nacional; 2 San Cristóbal; 3 Santiago; 4 San Pedro de Macoris; 5 Barahona; 6 La Romana; 7 San Juan; 8 Monte Cristi.
Ecuador	1 Quito; 2 Sierra Resto Urbano; 3 Sierra Rural; 4 Guayaquil; 5 Costa Resto Urbano; 6 Costa Rural.
Guatemala	1 Guatemala; 2 Central; 3 Sur Occidental; 4 Nor Occidental; 5 Norte; 6 Nor Oriental; 7 Sur Oriental.
Mexico	1 to 9 No labels.
Peru	1 Lima Metropolitana; 2 Costa (excluding Lima Metropolitana); 3 Sierra; 4 Selva.
Trinidad and Tobago	1 St. George; 2 Remainder.
Egypt	1 Urban Governorates; 2 Lower Urban; 3 Lower Rural; 4 Upper Urban; 5 Upper Rural.
Morocco	1 Sud; 2 Tensift; 3 Centre; 4 Nord-Ouest; 5 Centre-Nord; 6 Oriental; 7 Centre-Sud.
Tunisia	1 Tunis; 2 Nord Est; 3 Nord Ouest; 4 Centre Ouest; 5 Centre Est; 6 Sud.
Botswana	No regions identified.
Burundi	1 Imbo; 2 Mumirwa; 3 Mugamba; 4 Plateaux Centraux; 5 Depressions.
Ghana	1 Western; 2 Central; 3 Greater Accra; 4 Eastern; 5 Volta; 6 Ashanti; 7 Brong Ahafo; 8 Upper West, East and Northern.
Kenya	1 Nairobi; 2 Central; 3 Coast; 4 Eastern; 5 Nyanza; 6 Rift Valley; 7 Western.
Liberia	1 Sinoe; 2 Grand Gedeh; 3 Montserrado; 4 Remainder.
Mali	1 Kayes, Koulikoro; 2 Sikasso, Ségou; 3 Mopti, Gao, Tomboucto; 4 Bamako.
Senegal	1 Ouest; 2 Centre; 3 Nord-Est; 4 Sud.
Togo	1 Maritime; 2 Des Platelaux; 3 Centrale; 4 De La Kara; 5 Des Savanes.
Uganda	1 West Nile; 2 East; 3 Central; 4 West; 5 South-west; 6 Kampala.
Zimbabwe	1 Manicaland; 2 Mashonaland Central; 3 Mashonaland East; 4 Mashonaland West; 5 Matabeleland North; 6 Matabeleland South; 7 Midlands; 8 Masvingo; 9 Harare/Chitungwiza; 10 Bulawayo.
Indonesia	1 Java-Bali; 2 Outer java Bali I; 3 Outer Java Bali II.
Sri Lanka	1 Metro Colombo; 2 Colombo feeder areas; 3 South West lowlands; 4 Lower-South, Central Hill; 5 Upper-South, Central Hill; 6 Dry Zone, Irrigated; 7 Dry Zone, Rainfed.
Thailand	1 North; 2 Northeast; 3 Central; 4 South; 5 Bangkok.

Sources: Demographic and Health Surveys individual recode files.

TABLE 32. PARAMETER ESTIMATES, SOCIO-ECONOMIC MODEL

Country	Total births	Constant	Mother's education[a] (in years)			Father's education[a] (in years)			Father's occupation[b]			Region[c]									
			1-3	4-6	7+	1-3	4-6	7+	Manual	Sales and service	Professional and clerical	1	2	3	4	5	6	7	8	9	10
Bolivia	11 322	-1.792	-0.111	-0.319[d]	-0.896[d]	-0.030	-0.004	-0.229	0.112	-0.218[e]	-0.124	0.347	0.133	0.000							
Brazil	7 226	-2.872	-0.033	-0.263	-0.752	0.070	0.018	-0.345	-0.001	-0.086	-0.257	0.595	0.615	0.000	0.426	1.290	0.548				
Colombia	5 709	-2.467	-0.385[e]	-0.933[d]	-1.269[d]	-0.398[e]	-0.140	-0.105	0.134	-0.055	-0.915[e]	0.342	0.431	0.367	0.484	0.000					
Dominican Republic	8 499	-2.120	-0.341[d]	-0.479[d]	-0.800[d]	-0.125	-0.070	-0.232	-0.018	-0.032	-0.024	0.297	0.339	0.020	0.000	0.180	0.010	0.292	0.202		
Ecuador	6 554	-2.300	-0.432[d]	-0.696[d]	-1.016[d]	0.215	0.118	-0.137	-0.019	-0.144	-0.122	0.000	0.262	0.643[d]	0.153	0.497[e]	0.452[e]				
Guatemala	8 709	-2.427	-0.134	-0.224	-1.058[d]	-0.029	-0.293[e]	-0.318	-0.022	0.019	0.200	0.346	0.835	0.264	0.462	0.000	0.383	0.427			
Mexico	11 897	-2.469	-0.247[e]	-0.652[d]	-1.137[d]							0.088	0.266	0.179	0.000	0.044	0.254	0.639	0.190		
Peru	6 880	-2.267	-0.090	-0.182	-0.767[d]	-0.004	-0.073	-0.290	0.080	-0.250	-0.099	0.000	0.214	0.607[d]	0.706[d]						
Trinidad and Tobago	3 172	-3.058	-0.351	-0.851	-0.920	-0.537	-0.360	0.354	0.400	0.102	0.066	0.286	0.000								
Egypt	18 059	-2.215	-0.087	-0.078	-0.753[d]	0.007	-0.031	-0.328[d]				0.000	0.085	0.313[d]	0.429[d]	0.750[d]					
Morocco	11 994	-2.571	-0.185	-0.292	-0.825[d]	-0.070	-0.253[d]	-0.471[d]	0.048	-0.012	0.202	1.006	0.675	0.000	0.724	0.659	0.281	0.435			
Tunisia	8 429	-2.718	-0.111	-0.188	-0.586[e]	-0.088	0.006	-0.239	-0.332[d]	-0.242	-0.512[d]	0.000	0.118	0.633[d]	0.772[d]	0.313	0.670[d]				
Botswana	6 119	-2.766	-0.154	-0.364[e]	-0.256	-0.087	-0.519[e]	-0.040	0.147	-0.188	-0.382	0.000									
Burundi	6 033	-2.278	0.162	0.044	-0.619[e]	-0.141	-0.373[d]	-0.571[d]	-0.211	-0.406[d]	0.012	1.020	0.479	0.000	0.466	0.529					
Ghana	6 825	-2.407	-0.114	0.170	-0.052	-0.283	0.154	-0.152	-0.048	-0.226	-0.352[e]	0.400	0.884	0.178	0.229	0.000	0.362	0.203	0.586		
Kenya	13 347	-2.990	-0.129	-0.187[e]	-0.477[d]	0.067	-0.157	-0.274[d]	-0.022	0.076	-0.215	0.584	0.217	1.233	0.476	1.363	0.000	1.080			
Liberia	7 534	-1.376	-0.097	-0.197	-0.466[d]	0.177	-0.141	-0.068				0.229	0.043	0.141	0.000						
Mali	6 256	-1.717	-0.186	-0.247	-0.301	-0.101	-0.381	-0.569[d]	-0.217	0.349[e]	-0.195[e]	0.337	0.316	0.579	0.000						
Senegal	7 137	-1.674	0.106	-0.691[d]	-0.588[e]	0.176	-0.091	-0.148	-0.184[e]	-0.250[e]	-0.407[e]	0.000	0.004	0.079	0.338[d]						
Togo	5 162	-2.116	-0.088	-0.220	-0.607[e]	-0.411[e]	-0.395[d]	-0.341[e]				0.195	0.195	0.000	0.130	0.231					
Uganda	8 623	-1.898	0.203[e]	-0.033	-0.208	0.095	-0.054	-0.159	-0.124	-0.079	-0.142	0.288	0.195	0.084	0.258	0.000	0.234				
Zimbabwe	6 128	-2.839	0.177	-0.169	-0.280	-0.108	-0.061	-0.254	0.153	-0.161	-0.070	0.854	0.395	0.391	0.471	0.473	0.417	0.330	0.489		
Indonesia	20 388	-2.034	-0.023	-0.270[d]	-0.742[d]	-0.042	-0.098	-0.443[d]	-0.070	-0.104	0.028	0.000	0.201[d]	0.177[e]							
Sri Lanka	9 137	-2.735	-0.104	-0.568[d]	-0.513[d]	-0.058	-0.134	-0.366	0.033	0.115	-0.293	0.203	0.019	0.109	0.005	0.242	0.241	0.000			
Thailand	8 971	-3.269	0.184	-0.143	-0.574[e]	0.482	-0.212	-0.191	-0.070	-0.260	-0.181	0.564	0.883	0.495	0.574	0.000					
Americas	69 968	-2.419	-0.236	-0.511	-0.957	-0.105	-0.100	-0.163	0.083	-0.083	-0.159										
Northern Africa	38 482	-2.501	-0.128	-0.186	-0.721	-0.050	-0.092	-0.346	-0.142	-0.127	-0.155										
Sub-Saharan Africa	73 164	-2.206	-0.012	-0.189	-0.385	-0.062	-0.202	-0.258	-0.063	-0.111	-0.219										
Asia	38 496	-2.679	0.019	-0.327	-0.609	0.127	-0.148	-0.333	-0.036	-0.083	-0.149										
Overall	220 110	-2.375	-0.103	-0.321	-0.658	-0.051	-0.148	-0.247	-0.011	-0.098	-0.180										

Sources: Demographic and Health Surveys individual recode files.

NOTE: Singleton births born 2-15 years before the survey. Sample sizes are reduced where missing values occur for some of the variables.

[a]Reference group: No schooling.

[b]Reference group: Agriculture.

[c]Reference group: Region with the lowest net child mortality.

[d]Significant at 1 per cent level.

[e]Significant at 5 per cent level.

TABLE 33. ODDS RATIOS, SOCIO-ECONOMIC MODEL

Country	Total births	Mother's education[a] (in years) 1-3	4-6	7+	Father's education[a] (in years) 1-3	4-6	7+	Father's occupation[b] Manual	Sales and service	Professional and clerical	Region[c] 1	2	3	4	5	6	7	8	9	10
Bolivia	11 322	0.895	0.727	0.408	0.971	0.996	0.795	1.119	0.804	0.884	1.415	1.142	1.000							
Brazil	7 226	0.967	0.768	0.471	1.072	1.018	0.709	0.999	0.917	0.773	1.812	1.850	1.000	1.531	3.633	1.729				
Colombia	5 709	0.681	0.393	0.281	0.672	0.870	0.900	1.143	0.946	0.401	1.408	1.539	1.443	1.623	1.000					
Dominican Republic	8 499	0.711	0.619	0.449	0.883	0.932	0.793	0.982	0.969	0.976	1.345	1.404	1.020	1.000	1.197	1.010	1.339	1.224		
Ecuador	6 554	0.649	0.498	0.362	1.240	1.125	0.872	0.981	0.866	0.885	1.000	1.300	1.902	1.165	1.644	1.571				
Guatemala	8 709	0.874	0.799	0.347	0.972	0.746	0.727	0.978	1.019	1.221	1.414	2.305	1.302	1.587	1.000	1.467	1.532			
Mexico	11 897	0.781	0.521	0.321							1.092	1.305	1.196	1.000	1.045	1.289	1.895	1.209	1.374	
Peru	6 880	0.914	0.834	0.464	0.996	0.930	0.748	1.083	0.779	0.906	1.000	1.239	1.835	2.026						
Trinidad and Tobago	3 172	0.704	0.427	0.398	0.585	0.698	1.425	1.492	1.107	1.068	1.331	1.000								
Egypt	18 059	0.916	0.925	0.471	1.007	0.970	0.720				1.000	1.089	1.368	1.536	2.117					
Morocco	11 994	0.831	0.747	0.438	0.932	0.777	0.624	1.049	0.988	1.223	2.736	1.964	1.000	2.063	1.933	1.324	1.545			
Tunisia	8 429	0.895	0.828	0.556	0.916	1.006	0.788	0.717	0.785	0.599	1.000	1.125	1.883	2.164	1.368	1.954				
Botswana	6 119	0.858	0.695	0.774	0.916	0.595	0.960	1.158	0.828	0.683										
Burundi	6 033	1.176	1.045	0.538	0.868	0.688	0.565	0.810	0.666	1.012	2.772	1.614	1.000	1.594	1.697					
Ghana	6 825	0.892	1.185	0.949	0.753	1.166	0.859	0.953	0.798	0.703	1.493	2.421	1.195	1.257	1.000	1.436	1.225	1.797		
Kenya	13 347	0.879	0.829	0.621	1.070	0.855	0.760	0.978	1.079	0.806	1.793	1.242	3.432	1.610	3.908	1.000	2.945			
Liberia	7 534	0.907	0.821	0.627	1.194	0.868	0.934				1.258	1.044	1.151	1.000						
Mali	6 256	0.830	0.781	0.740	0.904	0.683	0.566	0.805	1.417	0.823	1.400	1.372	1.784	1.000						
Senegal	7 137	1.111	0.501	0.555	1.192	0.913	0.863	0.832	0.779	0.665	1.000	1.004	1.082	1.402						
Togo	5 162	0.915	0.802	0.545	0.663	0.674	0.711				1.215	1.215	1.000	1.139	1.260					
Uganda	8 623	1.225	0.967	0.812	1.100	0.947	0.853	0.883	0.924	0.867	1.334	1.215	1.088	1.294	1.000	1.264				
Zimbabwe	6 128	1.194	0.845	0.756	0.898	0.940	0.776	1.166	0.851	0.932	2.349	1.484	1.478	1.602	1.605	1.517	1.391	1.631	1.317	
Indonesia	20 388	0.978	0.763	0.476	0.959	0.907	0.642	0.933	0.901	1.028	1.000	1.223	1.194							
Sri Lanka	9 137	0.902	0.567	0.599	0.944	0.875	0.694	1.033	1.122	0.746	1.225	1.019	1.115	1.005	1.274	1.273	1.000			
Thailand	8 971	1.202	0.866	0.564	1.620	0.809	0.827	0.932	0.771	0.835	1.757	2.418	1.640	1.775	1.000					
Americas	69 968	0.790	0.600	0.384	0.901	0.905	0.850	1.087	0.920	0.853										
Northern Africa	38 482	0.880	0.830	0.486	0.951	0.912	0.708	0.868	0.881	0.856										
Sub-Saharan Africa	73 164	0.988	0.827	0.680	0.940	0.817	0.773	0.939	0.895	0.803										
Asia	38 496	1.020	0.721	0.544	1.136	0.863	0.717	0.965	0.921	0.862										
Overall	220 110	0.902	0.725	0.518	0.950	0.863	0.782	0.989	0.907	0.835										

Sources: Demographic and Health Surveys individual recode files.

NOTE: Singleton births born 2-15 years before the survey. Sample sizes are reduced where missing values occur for some of the variables.

[a]Reference group: No schooling.
[b]Reference group: Agriculture.
[c]Reference group: Region with the lowest net child mortality.

TABLE 34. PROPORTION OF BIRTHS IN EACH RISK GROUP, SOCIO-ECONOMIC MODEL

Country	Total births	Mother's education[a] (in years)			Father's education[a] (in years)			Father's occupation[b]			Region[c]									
		1-3	4-6	7+	1-3	4-6	7+	Manual	Sales and service	Professional and clerical	1	2	3	4	5	6	7	8	9	10
Bolivia	11 322	0.284	0.208	0.290	0.230	0.284	0.398	0.321	0.177	0.150	0.381	0.332	0.288							
Brazil	7 226	0.351	0.289	0.210	0.323	0.273	0.215	0.352	0.208	0.155	0.095	0.108	0.126	0.173	0.374	0.124				
Colombia	5 709	0.369	0.295	0.219	0.305	0.290	0.247	0.375	0.201	0.094	0.247	0.218	0.214	0.183	0.139					
Dominican Republic	8 499	0.343	0.287	0.264	0.269	0.244	0.322	0.218	0.246	0.095	0.141	0.079	0.150	0.123	0.137	0.094	0.166	0.110		
Ecuador	6 554	0.244	0.375	0.255	0.200	0.426	0.273	0.377	0.144	0.137	0.096	0.107	0.274	0.146	0.134	0.243				
Guatemala	8 709	0.245	0.145	0.064	0.283	0.187	0.108	0.202	0.141	0.076	0.210	0.128	0.234	0.139	0.083	0.099	0.106			
Mexico	11 897	0.268	0.351	0.210							0.088	0.081	0.158	0.084	0.150	0.097	0.104	0.084	0.155	
Peru	6 880	0.275	0.223	0.316	0.217	0.283	0.430	0.315	0.157	0.158	0.239	0.261	0.379	0.120						
Trinidad and Tobago	3 172	0.048	0.321	0.619	0.036	0.283	0.663	0.597	0.200	0.135	0.340	0.660								
Egypt	18 059	0.133	0.192	0.108	0.138	0.269	0.187				0.212	0.100	0.302	0.120	0.266					
Morocco	11 994	0.031	0.065	0.039	0.037	0.132	0.108	0.314	0.178	0.102	0.114	0.131	0.267	0.207	0.141	0.065	0.075			
Tunisia	8 429	0.075	0.218	0.094	0.050	0.274	0.222	0.559	0.132	0.142	0.157	0.170	0.163	0.173	0.177	0.161				
Botswana	6 119	0.095	0.191	0.414	0.049	0.092	0.283	0.590	0.224	0.092	1.000									
Burundi	6 033	0.079	0.107	0.040	0.103	0.237	0.078	0.149	0.086	0.033	0.169	0.102	0.090	0.492	0.147					
Ghana	6 825	0.068	0.100	0.349	0.015	0.043	0.576	0.235	0.089	0.143	0.082	0.114	0.095	0.154	0.102	0.174	0.135	0.144		
Kenya	13 347	0.094	0.213	0.359	0.055	0.167	0.573	0.212	0.241	0.189	0.083	0.174	0.099	0.128	0.190	0.166	0.159			
Liberia	7 534	0.057	0.086	0.146	0.031	0.089	0.399				0.167	0.199	0.180	0.454						
Mali	6 256	0.033	0.067	0.044	0.019	0.033	0.068	0.109	0.043	0.218	0.265	0.399	0.206	0.130						
Senegal	7 137	0.024	0.059	0.037	0.006	0.034	0.056	0.239	0.165	0.081	0.307	0.394	0.159	0.140						
Togo	5 162	0.079	0.126	0.064	0.063	0.215	0.168				0.394	0.228	0.109	0.118	0.151					
Uganda	8 623	0.167	0.237	0.182	0.086	0.294	0.421	0.053	0.291	0.116	0.039	0.181	0.306	0.041	0.340	0.094				
Zimbabwe	6 128	0.150	0.301	0.367	0.077	0.214	0.567	0.403	0.212	0.130	0.134	0.072	0.138	0.127	0.045	0.065	0.147	0.123	0.077	
Indonesia	20 388	0.211	0.399	0.192	0.147	0.417	0.332	0.264	0.185	0.149	0.660	0.233	0.107							
Sri Lanka	9 137	0.145	0.262	0.467	0.128	0.282	0.541	0.508	0.002	0.115	0.094	0.144	0.118	0.164	0.202	0.125	0.152			
Thailand	8 971	0.050	0.699	0.159	0.038	0.664	0.237	0.293	0.140	0.065	0.184	0.226	0.215	0.219	0.155					
Americas	69 968	0.270	0.277	0.272	0.233	0.284	0.332	0.345	0.184	0.125										
Northern Africa	38 482	0.080	0.159	0.080	0.075	0.225	0.173	0.436	0.155	0.122										
Sub-Saharan Africa	73 164	0.085	0.149	0.200	0.050	0.142	0.319	0.249	0.169	0.125										
Asia	38 496	0.135	0.453	0.273	0.104	0.454	0.370	0.355	0.109	0.110										
Overall	220 110	0.157	0.233	0.220	0.121	0.239	0.311	0.318	0.165	0.123										

Sources: Demographic and Health Surveys individual recode files.

NOTE: Singleton births born 2-15 years before the survey. Sample sizes are reduced where missing values occur for some of the variables.

[a]Reference group: No schooling.

[b]Reference group: Agriculture.

[c]Reference group: Region with the lowest net child mortality.

three years of schooling is about 10 per cent. When the mother has had four to six years of schooling the gains in survival chances for their children become stronger, averaging around 30 per cent and being statistically significant at the 5 per cent level in 10 countries. Only two countries now have estimated log odds which are positive (corresponding to excess mortality for this group): Burundi and Ghana. In six countries (Colombia, Ecuador, Mexico, Trinidad and Tobago, Senegal and Sri Lanka) the log odds for mothers having four to six years of schooling are below -0.5, corresponding to about 40 per cent survival advantage. When the mother has had seven or more years of schooling all 25 countries show a reduction in mortality compared with the no schooling group, with 19 of these being significant at the 5 per cent level. The average log odds is now -0.658, corresponding to an approximate halving of mortality risks for children of the most educated group of mothers as compared with those whose mothers had no schooling. Moreover, the strong advantages are widespread, with the log odds being below -0.5 for 18 of the 25 countries; the exceptions are Ghana, Uganda, Botswana, Zimbabwe, Mali, Liberia and Kenya. Thus all countries showing weak associations of child survival with maternal education are in sub-Saharan Africa. In fact, all the estimated contrasts of the highest and lowest groups for maternal education in the sub-Saharan African countries are weaker than any of the estimates for the countries of the Americas. Thus, the advantage for child survival of an educated mother is much greater in the Americas than in the other regions and much weaker in sub-Saharan Africa than elsewhere (see Hobcraft, 1992, for further discussion of this issue).

Husband's characteristics

The level of the husband's education is generally more weakly associated with child survival than is maternal education, although there are still gains with increasing education. Where the husband has had one to three years of education the overall average odds of mortality are 0.95:1, and the majority of countries show an improvement (16 of 24). With four to six years of schooling the overall odds ratio goes to 0.86:1, and 20 of 24 countries show gains in child survival compared with the no schooling group, with the exceptions being Brazil, Ecuador, Tunisia and Ghana. If the husband has had seven or more years of schooling the overall average odds ratio is further reduced to 0.78:1. It is worth noting that this average net gain (after controlling for the other socio-economic factors) is slightly less than the net gain associated with the mother having experienced just four to six years of schooling. The advantage is apparent in all countries other than Trinidad and Tobago, where the reference group is too small to provide a reliable basis for contrasts. But only two countries have parameter estimates below -0.5 for seven or more years of husband's schooling, as compared with six countries for mothers with four to six years of schooling and fully 18 for seven or more years of maternal education. The effects of husband's level of schooling are typically weaker in the countries of the Americas and perhaps a little stronger for the few Asian and Northern African countries included here.

The husband's occupation proves an even weaker correlate of child mortality once the other socio-economic covariates are controlled. There are really no grounds for systematically distinguishing the survival chances to age two of children born to women whose husbands are in agricultural or manual occupations. If anything, those in the manual group most often show a slight advantage (13 of 21). When the husband is in a sales or service occupation, there does usually seem to be a slight mortality advantage for the children. The overall average log odds for this group is -0.10 and the log odds are negative in 16 of the 21 countries. Even the children born to women with professional and clerical husbands do not appear to obtain much net survival advantage, with the overall average log odds being -0.18 (corresponding to a mortality reduction of 16 per cent), and five of the 21 countries proving exceptions to negative log odds ratios.

Region

Although results are presented for the estimated log odds for the regions within countries, these are not considered in any detail here, except to note that differentials are sometimes considerable and that full interpretation would be beyond the scope of a cou-

parative study such as this. However, some discussion of regional patterns is given for subsequent models.

Population impact

Table 35 shows the impact scores (population attributable log odds) associated with each category for every covariate in the socio-economic model. The discussion focuses on the total impact scores associated with each covariate, which are shown in table 36. First, it is clear that the potential gains from enhanced maternal education are greater than for the other socio-economic covariates considered here. Averaged across all the 25 countries, the impact score for maternal education is 0.412, suggesting that a maximal overall gain in survival chances to age two for children of about a third could be achieved if all women received at least seven years of education. In contrast, elimination of all regional variation within each country might lower child mortality by a maximum of just over a quarter, and providing all men with seven or more years of schooling or (implausibly) placing all men in professional or clerical occupations could only lower overall mortality levels by a maximum of about one seventh. These overall averages, as might be expected, hide considerable variation among countries and broad geographic regions.

Mother's education

Since maternal education exhibits the strongest and most persistent relationship with child survival, the patterns for the "impact" scores (population attributable log odds) are initially considered for this variable.[3] The impact scores for maternal education are generally fairly high in the Americas and Northern Africa, excepting Trinidad and Tobago where over 60 per cent of mothers already have seven or more years education. Fewer than a third of all births in the countries covered from these broad regions occur to women with seven or more years of education. The impact score is highest for Guatemala, where very few births occur to women with seven or more years of education (6 per cent), and yet the children of these women have a large survival advantage. In such a combination of circumstances (a highly selected group of women) it is even more doubtful than usual that their advantage would be transmitted to all women if they were all more highly educated. If the impact scores for these two regions (the Americas and Northern Africa) are compared with the range of variation in the log odds from table 32, it can be seen that the three Northern African countries and Guatemala have only yet achieved less than 20 per cent of the potential child survival gains from maternal education (the impact scores are more than 80 per cent of the difference of the log odds between the least and most educated groups). At the other extreme, Trinidad and Tobago has already effectively achieved all of the possible improvement from all women having seven or more years of education (ignoring the likelihood of differentiation within this group). In this sense of remaining possible gains in child survival from improving maternal education, Colombia, Dominican Republic and, perhaps more surprisingly, Ecuador appear to have achieved over 50 per cent of the gains that might accrue from universal exposure of mothers to at least minimal secondary education. Nevertheless, since differentials in child survival by level of maternal education are large in Latin America these remaining potential gains are still fairly substantial, being a maximum of at least 30 per cent mortality reduction for all countries (except Trinidad and Tobago) in these two regions.

The population attributable log odds for maternal education in the countries in Asia and sub-Saharan Africa are more variable. For the Americas and Northern Africa (other than Trinidad and Tobago), the lowest impact score was for Dominican Republic, at 0.334. In Asia, both Indonesia and Thailand are only about a third of the way to achieving the possible maximal gains in child survival from maternal education, despite 70 per cent of births occurring to women having four to six years of education in Thailand and a further 16 per cent to women with seven or more years. For Indonesia these proportions are 40 and 19 per cent respectively. Both countries could see a possible maximal improvement of over a third in child mortality with greater access to secondary education for women. Sri Lanka has little apparent room for gains in child survival through wider access to secondary education for women; this

TABLE 35. POPULATION ATTRIBUTABLE LOG ODDS, SOCIO-ECONOMIC MODEL

Country	Mother's education[a] (in years)			Father's education[a] (in years)			Father's occupation[b]			Region[c]									
	1-3	4-6	7+	1-3	4-6	7+	Manual	Sales and service	Professional and clerical	1	2	3	4	5	6	7	8	9	10
Bolivia	-0.031	-0.066	-0.260	-0.007	-0.001	-0.091	0.036	-0.039	-0.019	0.132	0.044	0.000							
Brazil	-0.012	-0.076	-0.158	0.022	0.005	-0.074	0.000	-0.018	-0.040	0.057	0.067	0.000	0.073	0.483	0.068				
Colombia	-0.142	-0.276	-0.278	-0.122	-0.040	-0.026	0.050	-0.011	-0.086	0.084	0.094	0.078	0.089	0.000					
Dominican Republic	-0.117	-0.137	-0.211	-0.034	-0.017	-0.075	-0.004	-0.008	-0.002	0.042	0.027	0.003	0.000	0.025	0.001	0.048	0.022		
Ecuador	-0.105	-0.261	-0.259	0.043	0.050	-0.037	-0.007	-0.021	-0.017	0.000	0.028	0.177	0.022	0.067	0.110				
Guatemala	-0.033	-0.032	-0.067	-0.008	-0.055	-0.034	-0.004	0.003	0.015	0.073	0.107	0.062	0.064	0.000	0.038	0.045			
Mexico	-0.066	-0.229	-0.238							0.008	0.021	0.028	0.000	0.007	0.025	0.066	0.016	0.049	
Peru	-0.025	-0.040	-0.242	-0.001	-0.021	-0.125	0.025	-0.039	-0.016	0.000	0.056	0.230	0.085						
Trinidad and Tobago	-0.017	-0.273	-0.570	-0.019	-0.102	0.235	0.239	0.020	0.009	0.097	0.000								
Egypt	-0.012	-0.015	-0.082	0.001	-0.008	-0.061				0.000	0.008	0.094	0.052	0.200					
Morocco	-0.006	-0.019	-0.032	-0.003	-0.033	-0.051	0.015	-0.002	0.021	0.115	0.089	0.000	0.150	0.093	0.018	0.033			
Tunisia	-0.008	-0.041	-0.055	-0.004	0.002	-0.053	-0.186	-0.032	-0.073	0.000	0.020	0.103	0.134	0.055	0.108				
Botswana	-0.015	-0.069	-0.106	-0.004	-0.048	-0.011	0.087	-0.042	-0.035										
Burundi	0.013	0.005	-0.025	-0.015	-0.088	-0.044	-0.031	-0.035	0.000	0.173	0.049	0.000	0.229	0.078					
Ghana	-0.008	0.017	-0.018	-0.004	0.007	-0.088	-0.011	-0.020	-0.050	0.033	0.101	0.017	0.035	0.000	0.063	0.027	0.085		
Kenya	-0.012	-0.040	-0.171	0.004	-0.026	-0.157	-0.005	0.018	-0.041	0.049	0.038	0.122	0.061	0.259	0.000	0.172			
Liberia	-0.006	-0.017	-0.068	0.005	-0.013	-0.027				0.038	0.009	0.025	0.000						
Mali	-0.006	-0.017	-0.013	-0.002	-0.013	-0.039	-0.024	0.015	-0.042	0.089	0.126	0.119	0.000						
Senegal	0.002	-0.041	-0.022	0.001	-0.003	-0.008	-0.044	-0.041	-0.033	0.000	0.002	0.012	0.048						
Togo	-0.007	-0.028	-0.039	-0.026	-0.085	-0.057				0.077	0.044	0.000	0.015	0.035					
Uganda	0.034	-0.008	-0.038	0.008	-0.016	-0.067	-0.007	-0.023	-0.016	0.011	0.035	0.026	0.011	0.000	0.022				
Zimbabwe	0.027	-0.051	-0.103	-0.008	-0.013	-0.144	0.062	-0.034	-0.009	0.115	0.028	0.054	0.060	0.021	0.027	0.048	0.060	0.021	0.000
Indonesia	-0.005	-0.108	-0.143	-0.006	-0.041	-0.147	-0.018	-0.019	0.004	0.000	0.047	0.019							
Sri Lanka	-0.015	-0.149	-0.239	-0.007	-0.038	-0.198	0.017	0.000	-0.034	0.019	0.003	0.013	0.001	0.049	0.030	0.000			
Thailand	0.009	-0.100	-0.091	0.018	-0.141	-0.045	-0.020	-0.036	-0.012	0.104	0.200	0.106	0.126	0.000					
Americas	-0.061	-0.155	-0.254	-0.016	-0.023	-0.029	0.042	-0.014	-0.019										
Northern Africa	-0.009	-0.025	-0.056	-0.002	-0.013	-0.055	-0.085	-0.017	-0.026										
Sub-Saharan Africa	0.002	-0.025	-0.060	-0.004	-0.030	-0.064	0.003	-0.020	-0.028										
Asia	-0.004	-0.119	-0.158	0.002	-0.073	-0.130	-0.007	-0.019	-0.014										
Overall	-0.022	-0.083	-0.141	-0.007	-0.031	-0.059	0.008	-0.017	-0.023										

Sources: Demographic and Health Surveys individual recode files.

[a]Reference group: No schooling.

[b]Reference group: Agriculture.

[c]Reference group: Region with the lowest net child mortality.

TABLE 36. SUMMARY OF IMPACT SCORES, SOCIO-ECONOMIC MODEL

Country	Mother's education[a]	Father's education[a]	Father's occupation[b]	Region[c]
Bolivia	0.538	0.130	0.103	0.176
Brazil	0.506	0.298	0.199	0.748
Colombia	0.573	-0.083	0.868	0.345
Dominican Republic	0.334	0.107	0.010	0.168
Ecuador	0.391	0.193	0.077	0.403
Guatemala	0.925	0.221	-0.187	0.389
Mexico	0.603			0.220
Peru	0.460	0.144	0.069	0.371
Trinidad and Tobago	0.060	-0.240	0.202	0.097
Egypt	0.645	0.259		0.354
Morocco	0.768	0.384	-0.168	0.497
Tunisia	0.482	0.183	0.222	0.420
Botswana	0.066	-0.023	0.391	
Burundi	0.612	0.423	-0.078	0.528
Ghana	0.043	0.067	0.270	0.361
Kenya	0.254	0.095	0.188	0.701
Liberia	0.376	0.034		0.072
Mali	0.265	0.516	0.144	0.335
Senegal	0.528	0.138	0.289	0.062
Togo	0.533	0.173		0.172
Uganda	0.196	0.084	0.097	0.105
Zimbabwe	0.153	0.088	0.089	0.435
Indonesia	0.487	0.249	-0.061	0.066
Sri Lanka	0.109	0.123	0.276	0.115
Thailand	0.392	0.023	0.112	0.536
Americas	0.488	0.096	0.168	0.324
Northern Africa	0.631	0.275	0.027	0.424
Sub-Saharan Africa	0.303	0.159	0.174	0.308
Asia	0.329	0.132	0.109	0.239
Overall	0.412	0.149	0.148	0.320

Sources: Demographic and Health Surveys individual recode files.
[a]Reference group: Seven or more years of schooling.
[b]Reference group: Professional and clerical.
[c]Reference group: Region with the lowest net child mortality.

arises partly because 47 per cent of mothers already have seven or more years of schooling and a further 26 per cent have four to six years, but there is also no evidence of differential child survival chances for these two groups of mothers in Sri Lanka.

Patterns in sub-Saharan Africa

Interpretation of the impact scores for the sub-Saharan African countries poses greater problems. In the discussion of the parameter estimates shown in table 32, it was noted that the improvements in child survival associated with seven or more years of schooling were generally less substantial compared with the uneducated group than in other regions and that there were more examples of the intermediate educational groups showing higher mortality than the uneducated. Specifically, exceptions arose for Burundi, Ghana, Senegal, Uganda and Zimbabwe. Moreover, some of the countries in this region have quite substantial fractions of mothers with seven or

more years of schooling. More than a third of mothers are in this advantaged category in Botswana, Ghana, Kenya and Zimbabwe (the only other countries among the 25 covered here with higher proportions educated are Trinidad and Tobago and Sri Lanka). The impact scores for maternal education are high (over 0.5) for Burundi, Senegal and Togo, corresponding to excess mortality of about two thirds; in all three countries most of the potential gains in child survival from improved maternal education remain to be achieved. Liberia has similar potential for more modest, though significant, gains in child survival of up to a third with universal female access to seven or more years of schooling. Elsewhere in these sub-Saharan African countries the apparent potential for improved child survival through longer maternal education is lower, mainly as a result of the small observed differentials by level of schooling.

Husband's characteristics

In assessing the impact scores of paternal education and husband's occupation, contrasts are made once again with the most advantaged group, namely, fathers with seven or more years of schooling and husbands in professional and clerical occupation. These results therefore look at the question of how far gains in child survival might be possible, as was the case in discussing maternal education.

The impact scores for paternal education (summarized in table 36) are generally weak, with only three countries (Morocco, Burundi and Mali) having values in excess of 0.3, which contrasts with fully 17 countries for maternal education. These three countries are also those where the net contrasts in child survival between those born to fathers with no education and with seven or more years of schooling are greatest. As was discussed earlier, table 32 generally showed weaker contrasts for father's education than for maternal education. Moreover, the proportions of husbands receiving seven or more years of education are generally higher than for mothers (Botswana providing the only and clear exception), so that there is less scope for structural gains.

The impact scores associated with the husband's occupation are weaker still, only exceeding 0.3 in Colombia (0.87, or a 139 per cent excess mortality) and Botswana (0.39, or a 48 per cent excess mortality). Net differentials are often weak and it is also implausible to suggest that the entire population could ever be employed in professional and clerical occupations. For these reasons, there seems little point in dwelling on these results further.

Region

The final variable represented in table 35 is the region within countries. Problems of interpretation abound, since the number of regions identified is arbitrary and highly country specific. Moreover, detailed interpretation would require knowledge of the health infrastructure and ecology of each country. Nevertheless, it is clear that there is striking variation within several countries, even after controlling for individual socio-economic variation. This finding contrasts with the earlier study by Hobcraft, McDonald and Rutstein (1984) on WFS, where differentials by type of place of residence (major urban, other urban and rural) were found to be generally weak after control for socio-economic variables, suggesting to the authors that health infrastructure did not play a critical role, although such an interpretation partially ignored the issue of greater sanitary problems in areas of temporary housing in cities. These new results suggest that regional variations are important even if urban-rural differentials are small.

In 14 of the 24 countries for which regions were identified, the summary or total impact score shown in table 36 is above 0.3 (a 35 per cent excess) and exceeds 0.5 (or a 65 per cent excess) in four of these. Thus the arbitrary regional differentiation identified here is associated with almost as much excess mortality as maternal education. The regions used in each country were shown in table 31 and reflect simply those that were easily identified on the individual recode files from DHS. A more elaborate study for any individual country might well use a more informative classification (e.g., further subdivision within Indonesia seems desirable and cross classification by type of place of residence might also be appropriate). The purpose of including regions in this study was largely as a further control,

but the striking variability in several countries and the lack of variability in others merits further investigation elsewhere.

In every country the reference group has been set as the region with the lowest net child mortality after control for the other variables, which maximizes the impact scores. Most reference groups are sensible and would be chosen anyway, but in several instances there is very little difference between the reference region and one or more other regions and in these cases the choice of reference region might not be an obvious one, although making little difference to the outcome.

The largest population attributable log odds for regions within countries occur for Brazil and Kenya, with impact scores of 0.75 and 0.70 respectively, which suggests that the net odds of child mortality in these two countries as a whole are about twice those for the most advantaged region. For Brazil, where the lowest net child mortality is in the South, all other regions experience excess child mortality of 53 to 85 per cent, except the Northeast where the odds of child mortality are about three and a half compared with the South (the log odds are 1.29 - see table 32). Since 37 per cent of the sample was in the Northeast, the contribution from this one region to the overall impact score of 0.75 is 0.48, or nearly two thirds of the excess mortality attributable to region in Brazil. Wiping out this regional differential simply for the North-east could more than halve child mortality in Brazil.

In Kenya, the reference region is the Rift Valley and net child mortality is also reasonably low in the Central region. The net excess is slightly over 50 per cent for Nairobi and the Eastern region (odds ratios of 1.5:1 or greater, see table 33). But three regions, the Coast, Nyanza and the Western region, stand out as having considerable net excess child mortality with odds ratios of three or more compared with the Rift Valley region. Since these three regions encompass about 45 per cent of the total number of births, the impact score is large for Kenya as a whole.

The impact scores for region are about 0.5 for three further countries, Morocco, Burundi and Thailand, corresponding to national excess odds of child mortality of about two thirds. For Morocco, child mortality is lowest in the Centre region and there is little excess in the Oriental (about a third) and Centre-Sud (about 50 per cent) regions. Odds of child death are about two for Tensift, the Nord-Ouest and Centre-Nord regions, encompassing 48 per cent of the total number of births and 2.7 for the Sud with 11 per cent of the births.

For Burundi, net child mortality is lowest in Mugamba region, with only 9 per cent of the sample. There is an approximate two-thirds excess mortality for Mumirwa, the Depressions and the Plateaux Centraux, which cover 74 per cent of the sample, and the odds of child death are 2.8:1 for Imbo region, with 16 per cent of the sample. The fairly large overall impact score arises from the high excess in the Imbo region and, particularly from about half the sample population being in the Plateaux Centraux.

For Thailand, net child mortality is considerably lower in Bangkok than in other regions. There is an approximate two thirds excess in the North, Central and South regions, with about 62 per cent of the total number of births and the net odds of death in the Northeast are about two and a half compared with Bangkok, encompassing nearly 23 per cent of the births.

Beyond these countries with the largest overall regional differentiation, there are a few other regions that have net odds ratios in excess of two to one, including the Central region of Guatemala, the Selva in Peru, Upper Rural Egypt, the Centre Ouest region of Tunisia, and Manicaland in Zimbabwe. The overall impact of regional variation in these countries is, however, moderate, being in the range 0.3 to 0.5, as are Colombia, Ecuador, Ghana and Mali.

For the 10 countries not yet discussed - Bolivia, Dominican Republic, Mexico, Trinidad and Tobago, Liberia, Senegal, Togo, Uganda, Indonesia and Sri Lanka - the net impact scores for regional variation in child survival are below 0.3. Thus, at least for the regions identified here, there is fairly low regional variation in child survival in these countries and any

areas of excess child mortality do not experience extreme risks or are not a significant portion of the population. This lack of differentiation is not simply related to the numbers of regions identified here, since several of these countries have a larger than average number of regions (e.g., Mexico (9), Dominican Republic (8), and Sri Lanka (7)). Among these 10 countries, with a total of 51 identified regions, only one region has an odds ratio of greater than 1.5.

F. The first births model

The model

The three sets of regression models considered so far, the counts-of-births, bio-demographic and socio-economic models, all include births of all orders. For many of the variables concerned with the timing of births, first births are fundamentally different from subsequent births. For first births it is impossible to define any variable concerning the preceding birth, since no such birth exists. The key aspect so far identified in the context of the timing of first births is the age of the mother and excess risks were shown in the tabular analysis for those mothers who bear their first child "too early". For second and higher order births, the most important element of timing is relative to other births, most particularly the preceding birth. For these reasons it seems sensible to undertake an analysis restricted only to first births which looks at a range of possible correlates. In the next section a more elaborate model is fitted to the mortality for second and higher order (later) births.

It is worth stressing at the outset that sample sizes for the first births model are smaller than used up to now. As a consequence relatively fewer parameter estimates are expected to be significantly different from the reference group. The sample sizes are shown in table 37. For every country there are more than a thousand first births during the observation period of 2-15 years before the surveys, with numbers ranging from 1,312 in Trinidad and Tobago to 5,677 for Indonesia. In total the experience of nearly 60,000 first births is covered in this analysis; this is almost certainly the first analysis of first births on this scale.

Parameter estimates

Table 37 shows the log odds for this first births model; the odds ratios are shown in table 38 and the sample distribution in table 39. The correlates of child mortality (to age two) considered include the sex of the child, the age of the mother at the birth, linear and quadratic trends over time, the mother's years of schooling, and the regions within the countries. Associations are examined for the broad (sub-) continental groupings used throughout this study and regularities are sought among countries and departures therefrom.

Sex differentials

Taken overall, first-born girls are about 80 per cent as likely to die before age two as boys (log odds of -0.233; odds ratio 0.79). Girls experience a survival advantage in all 25 countries, although this is only statistically significant at the 5 per cent level in seven countries. All three Asian countries show statistically significant and fairly sizeable advantages for first-born girls, with odds of death of about two thirds of those for first-born boys. The survival advantage for girls is generally weak for the three Northern African countries. Given the large standard errors on the parameter estimates it would be improper to make more of apparent differentials for individual countries.

Mother's age at first birth

As might have been expected from the earlier tabular analysis, there is clear evidence of a net excess mortality for children born to mothers under age 18. The log odds for first births to mothers under age 18 are positive for all 25 countries and exceed 0.5 (corresponding to an excess mortality of over 65 per cent) in seven of these; moreover 15 of the parameter estimates differ significantly at the 5 per cent level from the reference group (mothers aged 20-24 at the time of the birth). Thus there is

TABLE 37. PARAMETER ESTIMATES, FIRST BIRTHS MODEL

Country	Total births	Constant	Child's sex: female[a]	Mother's age at birth[b]: <18	18-19	25-29	30-34	Mother's education[c] (in years): 1-3	4-6	7+	Time[d]: Linear	Quadratic	Region[e]: 1	2	3	4	5	6	7	8	9	10
Bolivia	2 996	-2.070	-0.313[a]	0.424[f]	0.218	0.012	-0.206	-0.097	-0.678[f]	-1.322[f]	0.085	-0.005	0.264	0.041	0.000							
Brazil	2 292	-3.189	-0.497[f]	0.758[f]	-0.103	-0.282	-1.279	0.313	-0.203	-0.612	-0.044	-0.002	0.952	1.196	0.000	1.197	1.410	1.116				
Colombia	1 814	-2.382	-0.198	0.467	-0.189	-0.282	0.466	-0.327	-0.731	-1.238[f]	-0.057	-0.006	0.463	0.169	0.000	0.210	0.252					
Dominican Republic	2 547	-2.806	-0.009	0.434[a]	0.183	0.062	0.367	-0.019	-0.551[a]	-0.889[f]	0.009	0.004	0.427	0.490	0.293	0.000	0.804	0.134	0.187	0.178		
Ecuador	1 710	-2.129	-0.353	0.301	-0.245	0.040	-1.069	-0.292	-0.410	-1.085[f]	-0.067	0.006	0.000	0.055	0.664	0.022	0.312	0.796				
Guatemala	2 196	-2.428	-0.173	0.341[a]	-0.055	-0.151	-0.001	-0.168	-0.504[a]	-1.159[f]	0.007	-0.004	0.573	1.395	0.636	0.798	0.000	0.708	0.569	-		
Mexico	3 101	-3.064	-0.242	0.494[a]	0.550[a]	0.006	0.427	-0.061	-0.625[a]	-0.921[f]	-0.012	-0.005	0.000	0.841	0.512	0.325	0.990	0.542	0.892	0.575	0.680	
Peru	1 683	-2.167	-0.148	0.625[f]	0.026	-0.526	-0.303	-0.602[a]	-0.431	-1.102[f]	0.020	-0.002	0.381	0.000	0.373	0.774						
Trinidad and Tobago	1 312	-1.741	-0.096	0.089	-0.228	-0.343		-1.708	-1.668	-1.347	-0.001	-0.008	0.000	0.373								
Egypt	4 020	-2.418	-0.026	0.491[f]	0.143	0.330	0.621[a]	-0.007	-0.191	-0.723[f]	0.002	-0.004	0.000	0.190	0.414	0.479	0.931					
Morocco	2 748	-2.790	-0.086	0.646[f]	0.249	0.165	0.609	-0.538	-0.452	-0.876[a]	0.000	-0.005	1.419	1.036	0.000	0.960	0.797	0.638	0.585			
Tunisia	2 175	-2.924	-0.189	0.717[a]	0.035	0.215	-0.196	0.017	-0.504[a]	-0.867[a]	0.024	-0.004	0.000	0.389	0.693	0.830	0.324	0.833				
Botswana	1 966	-2.266	-0.367	0.092	-0.117	-0.752		0.251	-1.002[a]	-0.321	-0.121	0.006	0.000									
Burundi	1 657	-2.486	-0.169	0.277	0.501[f]	-0.107	0.191	-0.224	-0.157	-1.077[a]	0.069	-0.009	0.866	0.542	0.000	0.454	0.437					
Ghana	1 867	-3.327	-0.030	0.706[f]	0.177	-0.024	0.553	0.023	-0.086	-0.367[a]	0.088	-0.010	1.140	1.786	0.857	1.094	0.000	1.332	1.094	1.262		
Kenya	2 919	-3.003	-0.439[f]	0.211	-0.052	-0.249	-0.737	-0.018	-0.254	-0.645[f]	0.011	0.001	0.541	0.000	1.434	0.859	1.353	0.323	1.271			
Liberia	2 358	-1.396	-0.301[f]	0.438[f]	0.215	-0.406	-0.074	-0.174	-0.229	-0.522[f]	-0.011	0.003	0.146	0.183	0.000	0.044						
Mali	1 473	-1.571	-0.050	0.584[f]	0.222	-0.046	0.076	-0.485	-0.373	-0.730[a]	0.056	-0.008	0.073	0.006	0.448	0.000						
Senegal	1 917	-1.715	-0.240	0.278	0.048	0.390	0.689	0.201	-0.278	-1.346[f]	0.053	-0.013[a]	0.000	0.217	0.186	0.459						
Togo	1 377	-2.062	-0.208	0.045	0.312	0.811[a]		-0.561	-0.424	-0.467	-0.030	-0.001	0.340	0.000	0.173	0.397	0.346					
Uganda	1 974	-2.112	-0.205	0.620	0.396	-0.806	0.794	-0.033	-0.173	-0.527[f]	0.006	0.000	0.145	0.452	0.118	0.094	0.000	0.045				
Zimbabwe	1 624	-3.418	-0.300	0.073	0.138	-0.507	-0.663	-0.362	-0.477	-0.810[f]	0.161	-0.014	1.704	0.598	1.065	1.228	0.000	1.077	1.515	1.596	1.032	0.863
Indonesia	5 677	-2.177	-0.351[f]	0.478[f]	0.089	-0.161	-1.490[a]	0.065	-0.316[a]	-0.772[f]	0.001	-0.001	0.000	0.200	0.294							
Sri Lanka	3 014	-2.839	-0.408[a]	0.432	0.251	0.591[a]	0.051	-0.240	-1.170[f]	-0.832[f]	0.102	-0.015	0.319	0.122	0.266	0.136	0.269	0.258	0.000			
Thailand	3 228	-3.285	-0.438[a]	0.483[a]	0.469[a]	0.136	0.304	-0.018	-0.642[a]	-0.899[a]	-0.088	0.002	1.053	1.293	0.940	1.388	0.000					
Americas	19 651	-2.442	-0.225	0.437	0.018	-0.163	-0.200	-0.329	-0.645	-1.075	-0.007	-0.003										
Northern Africa	8 943	-2.711	-0.100	0.618	0.142	0.236	0.345	-0.176	-0.382	-0.822	0.009	-0.004										
Sub-Saharan Africa	19 132	-2.335	-0.231	0.332	0.184	-0.170	0.104	-0.138	-0.345	-0.681	0.028	-0.004										
Asia	11 919	-2.767	-0.399	0.465	0.270	0.189	-0.378	-0.064	-0.709	-0.834	0.005	-0.005										
Overall	59 645	-2.471	-0.233	0.420	0.129	-0.075	-0.040	-0.203	-0.501	-0.858	0.011	-0.004										

Sources: Demographic and Health Surveys individual recode files.

NOTE: First births, born 2-15 years before the survey.

[a]Reference group: Male children.

[b]Reference group: Mother aged 20-24 years at birth.

[c]Reference group: No schooling.

[d]Measured in years since 1 January 1975.

[e]Reference group: Region with the lowest net child mortality.

[f]Significant at 1 per cent level.

[a]Significant at 5 per cent level.

TABLE 38. ODDS RATIOS, FIRST BIRTHS MODEL

Country	Total births	Child's sex female[a]	Mother's age at birth[b]				Mother's education[c] (in years)			Region[d]									
			<18	18-19	25-29	30-34	1-3	4-6	7+	1	2	3	4	5	6	7	8	9	10
Bolivia	2 996	0.732	1.529	1.244	1.012	0.814	0.908	0.508	0.267	1.302	1.042	1.000							
Brazil	2 292	0.608	2.134	0.902	0.754	0.278	1.368	0.817	0.542	2.590	3.305	1.000	3.310	4.094	3.054				
Colombia	1 814	0.821	1.595	0.828	0.754	1.593	0.721	0.482	0.290	1.589	1.184	1.000	1.233	1.287					
Dominican Republic	2 547	0.991	1.543	1.200	1.064	1.444	0.981	0.577	0.411	1.533	1.633	1.340	1.000	2.235	1.144	1.206	1.194		
Ecuador	1 710	0.703	1.351	0.783	1.040	0.343	0.747	0.663	0.338	1.000	1.057	1.943	1.022	1.366	2.216				
Guatemala	2 196	0.841	1.407	0.947	0.859	0.999	0.845	0.604	0.314	1.773	4.035	1.889	2.222	1.000	2.031	1.766			
Mexico	3 101	0.785	1.639	1.733	1.006	1.533	0.941	0.535	0.398	1.000	2.318	1.669	1.385	2.692	1.719	2.441	1.778	1.974	
Peru	1 683	0.862	1.868	1.026	0.591	0.739	0.548	0.650	0.332	1.463	1.000	1.452	2.168						
Trinidad and Tobago	1 312	0.909	1.093	0.797	0.710		0.181	0.189	0.260	1.000	1.453								
Egypt	4 020	0.975	1.635	1.153	1.391	1.860	0.993	0.826	0.485	1.000	1.210	1.513	1.614	2.538					
Morocco	2 748	0.918	1.908	1.283	1.179	1.839	0.584	0.636	0.416	4.135	2.818	1.000	2.611	2.218	1.893	1.795			
Tunisia	2 175	0.828	2.049	1.036	1.239	0.822	1.018	0.604	0.420	1.000	1.476	1.999	2.294	1.383	2.301				
Botswana	1 966	0.693	1.096	0.890	0.472		1.285	0.367	0.726	1.000									
Burundi	1 657	0.844	1.320	1.651	0.899	1.211	0.800	0.855	0.341	2.378	1.720	1.000	1.574	1.549					
Ghana	1 867	0.970	2.026	1.194	0.976	1.739	1.024	0.918	0.693	3.126	5.963	2.357	2.987	1.000	3.788	2.987	3.532		
Kenya	2 919	0.645	1.235	0.950	0.780	0.479	0.982	0.776	0.525	1.718	1.000	4.196	2.360	3.870	1.381	3.565			
Liberia	2 358	0.740	1.550	1.240	0.666	0.928	0.840	0.795	0.593	1.157	1.201	1.000	1.045						
Mali	1 473	0.952	1.794	1.248	0.955	1.079	0.616	0.689	0.482	1.076	1.006	1.566	1.000						
Senegal	1 917	0.787	1.320	1.049	1.476	1.992	1.222	0.757	0.260	1.000	1.242	1.205	1.583						
Togo	1 377	0.812	1.047	1.366	2.250		0.571	0.654	0.627	1.404	1.000	1.189	1.488	1.413					
Uganda	1 974	0.814	1.858	1.485	0.447	2.213	0.967	0.841	0.590	1.156	1.571	1.125	1.099	1.000	1.046				
Zimbabwe	1 624	0.741	1.075	1.148	0.602	0.515	0.696	0.621	0.445	5.496	1.819	2.901	3.415	1.000	2.937	4.547	4.933	2.808	2.371
Indonesia	5 677	0.704	1.613	1.094	0.851	0.225	1.067	0.729	0.462	1.000	1.221	1.342							
Sri Lanka	3 014	0.665	1.541	1.285	1.806	1.052	0.787	0.310	0.435	1.375	1.130	1.304	1.146	1.309	1.294	1.000			
Thailand	3 228	0.646	1.621	1.598	1.146	1.356	0.983	0.526	0.407	2.866	3.643	2.559	4.007	1.000					
Americas	19 651	0.798	1.548	1.018	0.850	0.819	0.720	0.525	0.341										
Northern Africa	8 943	0.905	1.856	1.153	1.267	1.411	0.839	0.682	0.439										
Sub-Saharan Africa	19 132	0.794	1.394	1.202	0.844	1.109	0.871	0.708	0.506										
Asia	11 919	0.671	1.591	1.309	1.208	0.685	0.938	0.492	0.434										
Overall	59 645	0.792	1.522	1.138	0.927	0.961	0.817	0.606	0.424										

Sources: Demographic and Health Surveys individual recode files.

NOTE: First births, born 2-15 years before the survey.

[a]Reference group: Male children.

[b]Reference group: Mother aged 20-24 years at birth.

[c]Reference group: No schooling.

[d]Reference group: Region with the lowest net child mortality.

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TABLE 39. PROPORTION OF BIRTHS IN EACH RISK GROUP, FIRST BIRTHS MODEL

Country	Total births	Child's sex female[a]	Mother's age at birth[b]				Mother's education[c] (in years)			Time[d]	Region[e]									
			<18	18-19	25-29	30-34	1-3	4-6	7+	Linear	1	2	3	4	5	6	7	8	9	10
Bolivia	2 996	0.475	0.249	0.226	0.117	0.029	0.239	0.218	0.412	5.829	0.384	0.343	0.273							
Brazil	2 292	0.468	0.170	0.187	0.168	0.045	0.271	0.318	0.322	3.478	0.132	0.128	0.143	0.175	0.303	0.119				
Colombia	1 814	0.488	0.221	0.220	0.122	0.031	0.267	0.330	0.340	3.800	0.205	0.228	0.203	0.183	0.180					
Dominican Republic	2 547	0.489	0.332	0.244	0.088	0.020	0.239	0.283	0.384	3.853	0.175	0.076	0.157	0.113	0.126	0.103	0.142	0.108		
Ecuador	1 710	0.504	0.233	0.261	0.122	0.029	0.166	0.362	0.395	3.829	0.131	0.131	0.243	0.180	0.130	0.186				
Guatemala	2 196	0.497	0.325	0.265	0.080	0.014	0.235	0.187	0.107	4.557	0.228	0.119	0.241	0.135	0.075	0.105	0.097			
Mexico	3 101	0.478	0.244	0.218	0.135	0.033	0.182	0.387	0.340	4.052	0.086	0.077	0.164	0.085	0.146	0.093	0.101	0.088	0.159	
Peru	1 683	0.481	0.220	0.232	0.139	0.039	0.191	0.223	0.494	3.564	0.299	0.265	0.326	0.111						
Trinidad and Tobago	1 312	0.470	0.194	0.244	0.142		0.024	0.271	0.700	4.500	0.389	0.611								
Egypt	4 020	0.484	0.237	0.204	0.154	0.030	0.144	0.187	0.211	5.748	0.263	0.120	0.273	0.119	0.225					
Morocco	2 748	0.482	0.199	0.239	0.116	0.027	0.039	0.080	0.076	4.163	0.136	0.118	0.270	0.201	0.129	0.071	0.075			
Tunisia	2 175	0.505	0.050	0.181	0.182	0.042	0.088	0.293	0.148	5.559	0.193	0.180	0.157	0.147	0.181	0.143				
Botswana	1 966	0.492	0.322	0.330	0.047		0.052	0.159	0.564	5.515	1.000									
Burundi	1 657	0.485	0.150	0.249	0.101	0.019	0.077	0.122	0.059	4.326	0.194	0.092	0.081	0.502	0.131					
Ghana	1 867	0.487	0.302	0.269	0.058	0.011	0.059	0.101	0.459	5.216	0.086	0.109	0.111	0.159	0.116	0.163	0.133	0.123		
Kenya	2 919	0.514	0.402	0.276	0.034	0.009	0.067	0.221	0.516	6.036	0.127	0.173	0.106	0.117	0.173	0.160	0.145			
Liberia	2 358	0.481	0.466	0.207	0.072	0.014	0.066	0.106	0.182	3.355	0.157	0.163	0.202	0.478						
Mali	1 473	0.495	0.428	0.232	0.059	0.022	0.045	0.092	0.074	4.053	0.255	0.409	0.195	0.142						
Senegal	1 917	0.510	0.446	0.230	0.054	0.005	0.033	0.098	0.073	3.418	0.364	0.375	0.132	0.129						
Togo	1 377	0.473	0.372	0.280	0.047		0.090	0.180	0.116	5.525	0.428	0.222	0.100	0.121	0.129					
Uganda	1 974	0.492	0.491	0.248	0.031	0.005	0.175	0.252	0.224	6.055	0.040	0.182	0.300	0.039	0.324	0.114				
Zimbabwe	1 624	0.499	0.313	0.297	0.049	0.012	0.111	0.277	0.456	5.507	0.122	0.076	0.122	0.124	0.045	0.069	0.146	0.111	0.086	0.099
Indonesia	5 677	0.489	0.258	0.254	0.084	0.021	0.188	0.422	0.231	4.574	0.704	0.200	0.096							
Sri Lanka	3 014	0.495	0.085	0.157	0.240	0.077	0.112	0.229	0.561	3.934	0.105	0.169	0.121	0.162	0.204	0.109	0.131			
Thailand	3 228	0.487	0.133	0.204	0.176	0.045	0.034	0.682	0.227	4.130	0.216	0.207	0.215	0.173	0.189					
Americas	19 651	0.483	0.243	0.233	0.124	0.030	0.202	0.287	0.388	4.162										
Northern Africa	8 943	0.490	0.162	0.208	0.151	0.033	0.090	0.187	0.145	5.157										
Sub-Saharan Africa	19 132	0.493	0.369	0.262	0.055	0.012	0.077	0.161	0.272	4.901										
Asia	11 919	0.490	0.159	0.205	0.167	0.048	0.111	0.444	0.340	4.213										
Overall	59 645	0.489	0.274	0.238	0.105	0.026	0.128	0.243	0.307	4.583										

Sources: Demographic and Health Surveys individual recode files.

NOTE: First births, born 2-15 years before the survey.

[a]Reference group: Male children.

[b]Reference group: Mother aged 20-24 years at birth.

[c]Reference group: No schooling.

[d]Provides the average time of the sample of births, measured in years since 1 January 1975.

[e]Reference group: Region with the lowest net child mortality.

very clear evidence of a survival disadvantage for first births which occur too soon in the mother's life course, which persists with the socio-economic and regional controls shown here. Averaged across all 25 countries, the odds of death are 50 per cent greater for first births to very young mothers than for those born by 20-24 year old mothers. The odds are above average for each of the three countries from Northern Africa and for the three Asian countries included. The log odds associated with very young mothers are only below 0.3 for seven countries and six of these are in sub-Saharan Africa (Botswana, Togo, Zimbabwe, Burundi, Kenya and Senegal, plus Trinidad and Tobago). There is no obvious evidence to suggest any relationship with the fraction of first births occurring to mothers aged under 18.

The evidence for excess mortality of first births to mothers in their later teens is weaker, although 18 of the 25 parameter estimates are positive ($p=0.02$). In four countries the estimated excess mortality for first births to late teenage mothers is greater than that for births to early teenage mothers. The overall average excess corresponds to about a 14 per cent excess risk for first births to 18-19-year-old mothers as compared with those to women in their early twenties.

In most of the 25 countries considered here it is rare for women to have their first birth after age 25. As a consequence, the parameter estimates associated with older maternal ages at first birth are generally unreliable, especially for the 30-34 age group. There are no systematic patterns that can be discerned for these older ages at first birth. Rather, it seems that the risks of child death associated with entry into motherhood after age 25 are probably very similar to those for first births to women aged 20-24.

Mother's education

Mother's education is once again clearly associated with child survival chances. Even one to three years of schooling typically conveys an advantage in survival of the first birth: compared with first births to uneducated mothers the odds of child death in the first two years are only 0.82 to one. The log odds for first births to mothers with one to three years of schooling are negative in 19 of the 25 countries ($p=0.007$) and the six exceptions show no particular pattern. Once the mother has had four to six years of schooling there is a survival advantage compared with the uneducated group in all 25 countries, although only nine of these parameter estimates reach a 5 per cent significance level; the overall average advantage for this group is some 40 per cent (odds ratio = 0.606). The survival advantage associated with first births to mothers with seven or more years of schooling is universal (all 25 countries again) and substantial (with the parameter estimate being beyond -0.5 for 22 of the 25 countries and statistically significantly different from the uneducated group for 21 countries).

As would be expected from the earlier detailed discussion for the three models covering all births, the effects of maternal education are generally greater in the countries of the Americas and weakest in sub-Saharan Africa (all three countries with log odds smaller than -0.5 for the seven or more years education group are sub-Saharan Africa).

Region

The log odds for regions are often quite large, showing considerable variation in survival chances for first births depending upon where in the country they are born. For a few countries, the reference group (the region with the lowest net child mortality) has changed compared with the earlier analysis using the socio-economic model.

Population impact

Table 40 shows the population attributable risks for each category of all covariates in the model covering first births. Once again the discussion will focus mainly upon the summary impact scores across all categories of each variable, which are shown in table 41, and the more detailed results will only be referred to where interpretation is thus assisted. Looking first at the averages across all 25 countries, it can be seen that maternal education and region attain similar impact scores of about 0.45, corresponding to an odds ratio of 1.57 compared with the most favourable group. The 10-year time trend

TABLE 40. POPULATION ATTRIBUTABLE LOG ODDS, FIRST BIRTHS MODEL

Country	Child's sex	Mother's age at birth[b]				Mother's education[c] (in years)			Ten year trend[d]		Region[e]									
	female[a]	<18	18-19	25-29	30-34	1-3	4-6	7+	Linear	Quadratic	1	2	3	4	5	6	7	8	9	10
Bolivia	-0.148	0.106	0.049	0.001	-0.006	-0.023	-0.148	-0.545	0.848	-0.488	0.101	0.014	0.000							
Brazil	-0.233	0.129	-0.019	-0.047	-0.057	0.085	-0.065	-0.197	-0.437	-0.248	0.126	0.153	0.000	0.209	0.427	0.132				
Colombia	-0.097	0.103	-0.042	-0.034	0.015	-0.087	-0.241	-0.420	-0.567	-0.560	0.095	0.038	0.000	0.038	0.045					
Dominican Republic	-0.005	0.144	0.045	0.005	0.008	-0.005	-0.156	-0.342	0.092	0.363	0.075	0.037	0.046	0.000	0.101	0.014	0.027	0.019		
Ecuador	-0.178	0.070	-0.064	0.005	-0.031	-0.049	-0.149	-0.429	-0.669	0.579	0.000	0.007	0.161	0.004	0.041	0.148				
Guatemala	-0.086	0.111	-0.015	-0.012	0.000	-0.040	-0.094	-0.123	0.070	-0.392	0.131	0.166	0.154	0.108	0.000	0.074	0.055			
Mexico	-0.116	0.120	0.120	0.001	0.014	-0.011	-0.242	-0.313	-0.125	-0.527	0.000	0.065	0.084	0.028	0.145	0.050	0.090	0.051	0.108	
Peru	-0.071	0.137	0.006	-0.073	-0.012	-0.115	-0.096	-0.545	0.203	-0.226	0.114	0.000	0.121	0.086						
Trinidad and Tobago	-0.045	0.017	-0.055	-0.049	0.000	-0.040	-0.453	-0.942	-0.013	-0.811	0.000	0.228								
Egypt	-0.012	0.117	0.029	0.051	0.019	-0.001	-0.036	-0.152	0.021	-0.376	0.000	0.023	0.113	0.057	0.210					
Morocco	-0.041	0.129	0.060	0.019	0.017	-0.021	-0.036	-0.066	0.000	-0.505	0.193	0.123	0.000	0.193	0.103	0.045	0.044			
Tunisia	-0.096	0.036	0.006	0.039	-0.008	0.002	-0.148	-0.128	0.241	-0.427	0.000	0.070	0.109	0.122	0.059	0.119				
Botswana	-0.181	0.030	-0.039	-0.036	0.000	0.013	-0.160	-0.181	-1.208	0.615	0.000									
Burundi	-0.082	0.042	0.125	-0.011	0.004	-0.017	-0.019	-0.063	0.688	-0.861	0.168	0.050	0.000	0.228	0.057					
Ghana	-0.015	0.213	0.048	-0.001	0.006	0.001	-0.009	-0.168	0 884	-0.979	0.098	0.194	0.095	0.174	0.000	0.218	0.145	0.155		
Kenya	-0.225	0.085	-0.014	-0.008	-0.006	-0.001	-0.056	-0.333	0.113	0.105	0.069	0.000	0.151	0.100	0.234	0.052	0.184			
Liberia	-0.145	0.204	0.045	-0.029	-0.001	-0.011	-0.024	-0.095	-0.113	0.276	0.023	0.030	0.000	0.021						
Mali	-0.025	0.250	0.051	-0.003	0.002	-0.022	-0.034	-0.054	0.557	-0.808	0.019	0.002	0.087	0.000						
Senegal	-0.122	0.124	0.011	0.021	0.003	0.007	-0.027	-0.098	0.530	-1.325	0.000	0.081	0.025	0.059						
Togo	-0.098	0.017	0.087	0.038	0.000	-0.051	-0.076	-0.054	-0.302	-0.109	0.145	0.000	0.017	0.048	0.044					
Uganda	-0.101	0.304	0.098	-0.025	0.004	-0.006	-0.044	-0.118	0.064	0.049	0.006	0.082	0.035	0.004	0.000	0.005				
Zimbabwe	-0.150	0.023	0.041	-0.025	-0.008	-0.040	-0.132	-0.369	1.610	-1.401	0.208	0.045	0.130	0.153	0.000	0.074	0.221	0.177	0.089	0.086
Indonesia	-0.171	0.123	0.023	-0.014	-0.032	0.012	-0.133	-0.179	0.012	-0.073	0.000	0.040	0.028							
Sri Lanka	-0.202	0.037	0.039	0.142	0.004	-0.027	-0.268	-0.467	1.020	-1.538	0.033	0.021	0.032	0.022	0.055	0.028	0.000			
Thailand	-0.213	0.064	0.096	0.024	0.014	-0.001	-0.437	-0.204	-0.878	0.244	0.227	0.268	0.202	0.240	0.000					
Americas	-0.109	0.104	0.003	-0.023	-0.008	-0.032	-0.183	-0.429	-0.066	-0.257										
Northern Africa	-0.050	0.094	0.032	0.036	0.009	-0.007	-0.073	-0.116	0.087	-0.436										
Sub-Saharan Africa	-0.114	0.129	0.045	-0.008	0.000	-0.013	-0.058	-0.153	0.282	-0.444										
Asia	-0.195	0.075	0.053	0.051	-0.005	-0.005	-0.279	-0.283	0.051	-0.456										
Overall	-0.114	0.109	0.029	-0.001	-0.002	-0.018	-0.131	-0.264	0.106	-0.377										

Sources: Demographic and Health Surveys individual recode files.

NOTE: First births, born 2-15 years before the survey.

[a]Reference group: Male children.

[b]Reference group: Mother aged 20-24 years at birth.

[c]Reference group: No schooling.

[d]From 1 January 1975 to 1 January 1985.

[e]Reference group: Region with the lowest net child mortality.

TABLE 41. SUMMARY OF IMPACT SCORES, FIRST BIRTHS MODEL

Country	Mother's age at birth < 20[a]	Mother's education[b]	10-year trend[c]	Region[d]
Bolivia	0.155	0.607	0.360	0.115
Brazil	0.109	0.435	-0.685	1.048
Colombia	0.061	0.489	-1.126	0.217
Dominican Republic	0.189	0.386	0.456	0.319
Ecuador	0.006	0.459	-0.090	0.361
Guatemala	0.096	0.901	-0.322	0.688
Mexico	0.240	0.355	-0.652	0.621
Peru	0.143	0.346	-0.023	0.321
Trinidad and Tobago	-0.038	-0.089	-0.824	0.228
Egypt	0.146	0.534	-0.356	0.403
Morocco	0.188	0.753	-0.504	0.700
Tunisia	0.042	0.593	-0.185	0.478
Botswana	-0.009	-0.006	-0.593	
Burundi	0.167	0.978	-0.173	0.503
Ghana	0.261	0.191	-0.095	1.080
Kenya	0.071	0.255	0.218	0.790
Liberia	0.249	0.391	0.164	0.074
Mali	0.301	0.620	-0.250	0.108
Senegal	0.135	1.227	-0.795	0.165
Togo	0.104	0.286	-0.411	0.255
Uganda	0.402	0.360	0.113	0.132
Zimbabwe	0.064	0.268	0.209	1.183
Indonesia	0.146	0.472	-0.062	0.068
Sri Lanka	0.076	0.071	-0.518	0.191
Thailand	0.160	0.256	-0.634	0.937
Americas	0.107	0.432	-0.323	0.435
Northern Africa	0.125	0.627	-0.348	0.527
Sub-Saharan Africa	0.174	0.457	-0.161	0.477
Asia	0.127	0.266	-0.405	0.399
Overall	0.139	0.445	-0.271	0.458

Sources: Demographic and Health Surveys individual recode files.
[a]Reference group: Mother aged 20-24 years at birth.
[b]Reference group: Seven or more years of schooling.
[c]From 1 January 1975 to 1 January 1985.
[d]Reference group: Region with the lowest net child mortality.

averages an impact score of -0.271, suggesting an approximate 25 per cent average reduction in mortality by age two for first births over a 10-year period covering 1975 through 1984. The overall impact of having the first birth too soon (while the mother is a teenager) is associated with about 15 per cent excess and girls experience a net survival gain of about 11 per cent compared with boys.

Early child-bearing

The net impact of births to teenage mothers on child mortality is greatest for Uganda at 0.40, corresponding to a near 50 per cent excess mortality for all first births in Uganda as compared with all first births being delayed until the mother is in her twenties. Births to teenage mothers are also associated

with mortality excess of greater than 25 per cent in Mexico, Ghana, Liberia and Mali. These are not trivial effects at the population level and suggest that policies advocating and facilitating delayed entry into motherhood would be well worth pursuing in at least these countries. But clearly some of the other variables are associated with even greater excess mortality.

Mother's education

The impact scores presented in tables 40 and 41 for maternal education again indicate the excess mortality associated with some mothers having fewer than seven years of schooling. Once again, the apparent potential gains are below average for most sub-Saharan African countries, although Burundi, Mali and Senegal are for once striking exceptions. Along with Guatemala and Morocco, these three countries have very low fractions of new mothers who have had seven or more years of schooling and the survival advantage for their children is considerable. The combination of these elements implies an overall mortality excess of above 85 per cent in all five countries, arising from roughly 90 per cent of the population achieving considerable survival improvements (if the survival rate estimated from a very highly selected group of women were to be applicable once female secondary education becomes universal). The three Northern African countries also show above average potential for gains from universal achievement of female secondary education, with child mortality for first births being about two thirds higher than if all first births experienced the mortality of those born to mothers with seven or more years of schooling.

Time trends

The overall impact of estimated time trends for the period from January 1975 to January 1985 shows considerable variation among countries.[4] Over this 10-year period, the odds of mortality of first births seem to have worsened in several countries and show major improvements in others. However, considerable caution is warranted in examining these results, since the parameter estimates for time and for time squared are very rarely significantly different from zero. As will be shown later, the estimated time trends from the larger samples of later births are less variable.

Region

The first birth survival population impact scores for regions vary enormously among countries. The largest value is for Zimbabwe, which is probably partly a chance occurrence, because the region with the lowest net mortality for first births by age two, Matabeleland North, only had a sample of 73 births, being 4.5 per cent of the total. The parameter estimate for this region thus has a very high standard error and is probably too low. If the same region, Bulawayo, as was used for the reference group in the socio-economic model had been combined with the regions with lower mortality risks as a reference group, the impact score would be reduced to about 0.722. There is also some possibility that at least part of the high impact score for Ghana is due to an implausibly low net risk for the reference group (based upon 217 births), although here the reference region, Volta, is the same as in the socio-economic model.

However, these results for first births should not be discounted too heavily, since the impact scores for first births are higher than those for all births in the socio-economic model for 18 of the 24 countries where regions are identified ($p=0.011$), suggesting quite strongly that patterns of relative advantage by region are indeed more extreme for first births than for all births (or for later births, since the impact score for region for first births is again higher for 18 of the 24 countries). Perhaps differential access to health facilities, if this is what the regional variation captures, is more crucial for first births since the woman can at that stage have no evidence of obstetric difficulties which may lead to more attempts to access care for subsequent births.

Certainly the extent of apparent variation in survival chances for first-born children among regions within several countries should be a major source for concern. The odds of death in the first two years of life are about doubled in Guatemala, Morocco and Kenya, two and a half-fold in Thailand, and roughly tripled in Brazil, Ghana and Zimbabwe, when compared with the risks in the best region of these

countries. In almost all of these countries the reference region experiences a considerable first birth survival advantage over virtually the whole of the remainder of the country (see the log odds in table 37).

Of course there are still some variations among the remaining regions. In Guatemala, the Norte (the reference region) has the huge apparent advantage; the odds of death are four times as high in the Central region, and are about doubled for the remaining regions. In Morocco, the Centre region (the reference region) has the major survival advantage, the odds of death are four to one for the Sud and again about doubled in the remaining regions. For Kenya, risks of death for first births are low to moderate in Central (the reference region), Rift Valley and Nairobi (with an approximate 50 per cent excess) and the odds ratios exceed three to one for the Western, Nyanza and the Coast regions. In Thailand, Bangkok (the reference group) has very low risk of death, odds are two and a half to three for the North and Central regions and exceed three and a half for the Northeast and the South. First births in the South region of Brazil experience a major survival advantage over all other regions, with the odds of death being about 2.6 for Rio, just over three for São Paulo, the North and Central/Southeast regions and about four for the Northeast. In Ghana, Volta (the reference region) seems especially advantaged, with odds of 2.4 for Greater Accra, about three for the Western, Eastern, and Brong Ahafo regions, over three and a half for Ashanti and the Upper West, East and Northern and as high as six to one for the Central region. In Zimbabwe, risks are especially (and implausibly) low for Matabeleland North. It is preferable to examine results which take the combination of Matabeleland North, Mashonaland Central and Bulawayo regions as the reference group, whereupon the overall impact score for regional variation in the survival chances of first births reduces to 0.722, corresponding to odds of mortality of about twice the level in the reference region, compared with three in the original analysis. With this renormalization, several regions (Mashonaland East and West, Matabeleland South, and Harare/Chitungwiza show odds of between 1.5 and 1.9, and there is a two and a half to threefold excess in the Midlands, Masvingo and Manicaland. Further countries indicating fairly sizeable regional differentials in survival of first births include Mexico, Burundi, Tunisia and Egypt.

G. The later births model

The model

The final set of regression models to be considered are the most complex yet. This analysis is restricted to second and higher order births ("later" births) occurring to women aged under 35 years at the time of the birth in the period 2-15 years before the surveys and once again examines the correlates of survival to age two using logistic regression.

Since first births are excluded, it is possible to include a range of correlates associated with the births preceding the index birth, including the length of the preceding interval, the survival status of the immediately preceding birth, and information (for third and higher order births) concerning the survival status of "earlier" births (those before the previous birth in relation to the index birth). These variables attempt to capture the observable part of death clustering within families, which could be available at the time of any pre- and post-natal care for the index child. It is more helpful to try to capture the observable part of within-family heterogeneity in this way, which can inform practice by identifying high risk pregnancies and births, rather than simply using variance components or multilevel models to capture "unobserved" within-family clustering of child mortality as has been attempted by a number of authors (Zenger, 1993; Curtis, McDonald and Diamond, 1993; Guo, 1993). Direct information on outcomes for children born subsequent to the index child (or equivalently, for all children born to a particular mother) is deliberately not used for several reasons: first, these outcomes cannot be relevant to any pre- and post-natal care given to a mother; secondly, the survival chances of births subsequent to the index child are at least partly determined by the outcomes for the index child

(e.g., the death of the index child leads to a short interval and raises the risk of death for the next child with possible further implications for subsequent births), leading to reverse causation; and thirdly, though less crucially, provided that caution is used in interpreting the results, there could be no possible backward causal link.

A number of other possible correlates of child survival associated with information concerning the timing and survival status of births before the index birth were also explored but, for a variety of reasons, proved difficult or impossible to use. For example, a clear decision had to be taken on how to handle the timing of earlier births. The choices were essentially between the "counts of births" for clearly defined periods of time, as used in the first series of models, or defining information about the previous birth interval including survival status at the time of the index birth. Any attempt to use both types of approach runs into hugely complex difficulties of interpretation of individual regression coefficients because of near confounding. For example, knowledge as to whether the preceding birth interval was greater or less than two years captures most of the information contained in a count of births in the two years preceding the index birth. Similarly, knowing that the previous birth interval was in the range of two to four years tells much about counts for both the periods of two to four years and up to two years preceding the index birth. Since it was imperative to include the survival status of the preceding birth as a correlate it was much simpler to use the length of the previous birth interval as a correlate. This also permits a finer level of detail on the length of the interval to be identified.

A further example of a correlate that has been explored but not included in the final models is the information on whether or not the preceding birth interval is "firmly or imprecisely" dated, which was used in part one of this report. As was shown earlier, there is a strong association between imprecise dating of births and their survival status. Inclusion of this variable in the models makes for large variations in the parameter estimates associated with the survival status of the preceding birth, since there is partial confounding. On the other hand, the inclusion of an indicator variable for the precision of dating hardly affected any of the other parameter estimates, thus most strongly suggesting that the observed relationships are not distorted by imprecise dating. In view of this it was felt preferable to omit this variable from the models and thus obtain consistent and interpretable results concerning the association of the survival of the index child with the survival of the preceding birth, although the near confounding also means that care is required in interpretation.

One further correlate of survival of the index child which ought to be considered is not included here. It is well known (e.g., Hobcraft, McDonald and Rutstein, 1985; Palloni and Millman, 1986) that a rapid subsequent pregnancy is also associated with increased mortality risks for the index child. These effects do not really begin to have much impact until the second year of life, and inclusion in the models would have led to a number of complexities. It would no longer have been appropriate to use logistic models, since the occurrence of the next pregnancy and the resulting birth have to be treated as time-dependent covariates if reverse causality is not to be introduced. A short interval to the next birth is often directly determined by the death of the index child interrupting breast-feeding and thus directly altering the timing of the resumption of full reproductive function. The use of hazards models would have forfeited some of the comparability with all the earlier models. For reasons of added complexity and non-comparability with other results in this study it was decided to omit the timing of the subsequent birth and related information on breast-feeding patterns (which would only have been available for births in the five years before the surveys) from these models.

Parameter estimates

The results of fitting the model for later births to the data from the 25 DHS will now be examined. The variables that are included in the models will be discussed during the interpretation of the results.

Table 42 shows the sample sizes used for these models. For each country, except Trinidad and Tobago, the models are based upon the analysis of

TABLE 42. PARAMETER ESTIMATES, LATER BIRTHS MODEL

Country	Total births	Constant	Child's sex female[a]	Birth order[a]		Mother's age at birth[a]				Preceding birth interval[a] (months)				Survival status of preceding birth[a]			Deaths for earlier births[a]					
				4-6	7+	<18	18-19	25-29	30-34	<18	18-23	48-71	72+	Dead	Maybe dead	Twin	Of 3 1	Of 4-6 1	2+	Of 7+ 1	2	3 or more
Bolivia	9 318	-2.086	-0.174[j]	0.067	0.408[k]	0.113	0.144	-0.176[k]	-0.383[j]	0.890[j]	0.490[j]	-0.502[j]	-0.564[k]	0.356[j]	1.651[j]	0.267	0.019	0.289[k]	0.200	0.116	-0.086	-0.099
Brazil	5 513	-2.984	-0.249[j]	-0.082	-0.182	0.203	0.340	0.008	-0.167	0.799[j]	0.465[j]	0.210	-0.624	0.671[j]	2.016[j]	-0.725	0.608[k]	0.179	0.692[k]	0.485	0.648[k]	1.002[j]
Colombia	4 060	-3.186	-0.024	0.146	0.299	0.499	0.126	-0.209	0.208	0.857[j]	0.268	-0.759[k]	-0.187	0.558[j]	1.507[k]	0.564	0.446	0.180	0.536	0.033	-0.256	0.558
Dominican Republic	7 773	-2.684	-0.244[j]	-0.237	-0.105	0.276	-0.109	-0.047	-0.031	0.858[j]	0.314[k]	-0.081	0.408	0.732[j]	1.405[j]	-0.467	0.292	0.433[k]	0.852[j]	0.407	0.245	0.385
Ecuador	4 878	-2.422	-0.183	0.116	0.211	0.244	-0.017	-0.089	-0.312	0.832[j]	0.035	-0.651[k]	0.124	0.538[j]	0.807[k]	0.759	0.791[j]	0.187	0.061	-0.183	0.263	0.070
Guatemala	7 357	-2.834	-0.240[j]	-0.084	0.211	0.422[k]	0.370[k]	0.146	-0.018	1.211[j]	0.529[j]	-0.198	0.318	0.438[j]	1.005[j]	-0.398	0.644[j]	0.505[j]	0.603[j]	-0.253	0.308	0.562
Mexico	8 763	-2.917	-0.360[j]	0.384[j]	0.439[k]	0.673[j]	0.322[k]	-0.147	-0.431[j]	0.703[j]	0.339[j]	-0.206	-0.490	0.007	1.069	-0.326	0.676[k]	0.294	0.284	0.072	0.211	0.956[j]
Peru	5 352	-2.878	-0.098	0.121	0.303	0.491	0.176	-0.111	-0.143	0.859[j]	0.433[j]	-0.422	-1.220[k]	0.518[j]	1.247[j]	0.340	-0.339	0.038	-0.304	-0.677[k]	0.246	-0.130
Trinidad and Tobago	2 726	-3.286	-0.144	0.153	-1.274	1.431[j]	0.529	0.055	-0.146	0.520	-0.175	-0.115	0.000	0.073			-0.280	1.291[j]	-0.150	1.432	3.718[j]	
Egypt	14 156	-2.739	0.034	0.079	-0.004	0.225	0.104	-0.188[j]	0.024	1.284[j]	0.622[j]	-0.582[j]	-0.143	0.276[j]	0.729[j]	0.143	0.496[j]	0.279[j]	0.161	0.160	0.665[j]	0.569[j]
Morocco	10 181	-2.703	-0.107	0.057	0.005	0.334	0.273[k]	-0.005	-0.016	0.829[j]	0.272[j]	-0.734[j]	-0.603	0.517[j]	0.807[j]	-0.190	0.358	0.210	0.576[j]	0.254	0.237	0.464
Tunisia	6 774	-3.686	-0.076	0.279[k]	0.341	0.999	0.207	-0.056	-0.285	1.349[j]	0.494[j]	-0.219	0.054	0.238	1.520[j]	0.525	0.566	0.516[j]	0.406	0.331	0.463	0.312
Botswana	4 375	-2.842	-0.306[k]	0.085	-0.075	0.477	-0.317	0.047	0.022	0.866[j]	0.447[k]	-0.029	-0.284	0.602[j]	0.402	-1.103	1.234[j]	0.367	0.193	-0.107	0.606	
Burundi	5 113	-2.416	-0.226[j]	0.116	0.160	-0.001	-0.020	-0.160	-0.280[k]	0.593[j]	0.353[j]	-0.455[k]	-0.481	0.534[j]	1.076[j]	0.668	0.197	0.252	0.341	0.322	0.404	1.384[j]
Ghana	5 548	-2.454	-0.126	0.070	0.060	0.535[k]	0.047	-0.071	-0.005	0.596[j]	0.442[j]	-0.146	-0.002	0.438[j]	0.440[k]	-0.138	0.261	0.083	0.199	0.257	-0.095	-0.315
Kenya	11 145	-3.185	-0.064	-0.165	0.076	-0.114	0.107	-0.195	-0.118	0.716	0.380	-0.399	-0.888[k]	0.951	1.215	0.081	0.344	0.443	0.196	0.144	0.179	-0.159
Liberia	6 820	-1.709	-0.202[j]	-0.199[k]	-0.094	0.299[k]	0.048	-0.114	-0.077	0.630[j]	0.389[j]	-0.389[j]	-1.052[j]	0.764[j]	1.472[j]	0.065	0.193	0.258[k]	0.386[j]	-0.013	0.505[k]	0.029
Mali	5 376	-2.488	-0.101	-0.050	-0.053	0.009	0.338[k]	0.051	-0.057	1.259[j]	0.525[j]	-0.555[j]	-0.540	0.372[j]	0.704[j]	0.362	0.273	0.098	0.280	0.073	0.162	0.229
Senegal	6 330	-2.104	-0.114	-0.034	-0.081	0.451[j]	0.077	-0.068	0.123	0.548[j]	0.371[j]	-0.312	-0.513	0.515[j]	0.847[j]	-1.102	0.062	0.526[j]	0.162	-0.034	0.173	0.859[j]
Togo	4 338	-2.332	0.091	-0.197	0.123	-0.193	0.370	-0.053	0.023	0.484[j]	0.189	-0.482[k]	0.229	0.697[j]	0.328	-0.170	0.113	0.231	0.651[k]	0.223	-0.115	-0.004
Uganda	6 786	-2.439	-0.115	-0.127	-0.361	0.125	0.134	0.102	-0.072	0.736[j]	0.470[j]	-0.184	-0.331	0.572[j]	0.454	0.502	-0.505	0.308[k]	0.393	0.183	0.645[k]	0.671
Zimbabwe	5 108	-3.221	-0.382[j]	0.222	0.737[j]	0.279	-0.162	-0.299	-0.487[k]	0.870[j]	0.330[k]	-0.116	0.307	0.395[k]	1.005	-0.122	0.007	0.186	-1.119	-0.332	0.364	-0.785
Indonesia	15 103	-2.246	-0.274[j]	-0.003	0.211	0.326[k]	0.211	-0.100	-0.172	0.761[j]	0.347[j]	-0.362[j]	-0.244	0.461[j]	1.052[j]	0.507	0.312	0.383[j]	0.453[k]	0.201	0.603[k]	0.303
Sri Lanka	6 339	-2.890	-0.359[j]	-0.075	-0.045	0.471	-0.325	-0.031	-0.219	0.897[j]	0.502[j]	0.082	0.365	0.583[k]	0.316	0.338	1.421[j]	0.830[j]	0.733	0.598	0.838	0.410
Thailand	5 841	-3.980	-0.391[j]	-0.056	0.656	0.671	0.422	0.013	0.194	0.962[j]	0.424[k]	-0.560[k]	0.219	-0.229	2.091[j]	-0.324	-0.279	0.410	1.066[k]	-0.291	0.287	-0.126
Americas	55 740	-2.809	-0.191	0.065	0.034	0.484	0.209	-0.063	-0.158	0.837	0.300	-0.303	-0.248	0.432	1.338	0.002	0.317	0.377	0.308	0.159	0.588	0.413
Northern Africa	31 111	-3.043	-0.050	0.138	0.114	0.519	0.195	-0.083	-0.092	1.154	0.463	-0.512	-0.231	0.344	1.019	0.159	0.473	0.335	0.381	0.248	0.455	0.449
Sub-Saharan Africa	60 939	-2.519	-0.154	-0.028	0.049	0.187	0.062	-0.076	-0.093	0.730	0.389	-0.307	-0.355	0.584	0.794	-0.096	0.218	0.275	0.168	0.072	0.283	0.212
Asia	27 283	-3.039	-0.341	-0.045	0.274	0.489	0.103	-0.039	-0.066	0.874	0.424	-0.280	0.113	0.272	1.153	0.174	0.485	0.541	0.751	0.169	0.576	0.196
Overall	175 073	-2.749	-0.177	0.023	0.079	0.370	0.136	-0.068	-0.113	0.836	0.370	-0.327	-0.246	0.463	1.048	0.002	0.316	0.351	0.314	0.136	0.449	0.311

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TABLE 42 (*continued*)

Country	Mother's education[a] (in years)			Time[b]		Region[c]									
	1-3	4-6	7+	Linear	Quadratic	1	2	3	4	5	6	7	8	9	10
Bolivia	-0.229[j]	-0.375[j]	-0.954[j]	-0.008	0.000	0.425	0.244	0.000							
Brazil	-0.037	-0.197	-0.679[j]	0.000	-0.005	0.223	0.319	0.089	0.000	0.931	0.117				
Colombia	-0.334	-0.752[j]	-0.763[j]	-0.049	0.002	0.344	0.566	0.491	0.536	0.000					
Dominican Republic	-0.236	-0.247	-0.582[j]	-0.035	0.002	0.228	0.262	0.064	0.000	0.077	0.071	0.377	0.211		
Ecuador	-0.415[j]	-0.747[j]	-0.952[j]	-0.025	0.000	0.000	0.297	0.626	0.007	0.452	0.333				
Guatemala	-0.205[k]	-0.345[k]	-1.238[j]	-0.022	-0.001	0.215	0.532	0.191	0.336	0.000	0.322	0.334			
Mexico	-0.251[k]	-0.477[j]	-0.798[j]	0.004	-0.002	0.285	0.310	0.285	0.167	0.000	0.461	0.768	0.385	0.470	
Peru	-0.037	-0.256	-0.933[j]	-0.023	0.003	0.000	0.363	0.879	0.737						
Trinidad and Tobago	0.206	-0.480	-0.317	-0.193[j]	0.017[k]	0.477	0.000								
Egypt	-0.073	-0.016	-0.895[j]	0.007	-0.005[k]	0.000	0.080	0.251	0.322	0.584					
Morocco	-0.191	-0.430[k]	-0.752[j]	-0.022	-0.003	0.813	0.473	0.000	0.446	0.494	0.187	0.318			
Tunisia	-0.187	-0.165	-0.405	-0.004	-0.004	0.000	0.167	0.765	0.731	0.371	0.823				
Botswana	-0.255	-0.219	-0.222	0.019	-0.004	0.000									
Burundi	0.141	-0.113	-0.931[j]	0.045	-0.011[j]	0.664	0.416	0.000	0.483	0.488					
Ghana	-0.260	0.170	-0.084	-0.093[j]	0.007[k]	0.196	0.649	0.006	0.005	0.209	0.076	0.000	0.550		
Kenya	-0.199	-0.320[j]	-0.650[j]	-0.093[j]	0.009[j]	0.651	0.320	1.145	0.442	1.226	0.000	0.992			
Liberia	-0.027	-0.293[k]	-0.447[j]	0.007	-0.002	0.279	0.000	0.149	0.068						
Mali	-0.373	-0.385[k]	-0.621[k]	-0.020	-0.003	0.526	0.449	0.804	0.000						
Senegal	-0.062	-0.653[j]	-0.489[k]	-0.050[k]	0.004	0.000	0.067	0.078	0.308						
Togo	-0.161	-0.238	-0.999[j]	-0.011	0.000	0.082	0.182	0.050	0.000	0.286					
Uganda	0.173	-0.094	-0.288[k]	0.075[k]	-0.005	0.195	0.027	0.045	0.268	0.000	0.100				
Zimbabwe	0.198	-0.232	-0.258	0.079	-0.008	0.923	0.641	0.576	0.427	0.790	0.539	0.464	0.461	0.357	0.000
Indonesia	-0.151	-0.394[j]	-1.048[j]	0.020	-0.004	0.000	0.109	0.005							
Sri Lanka	-0.114	-0.457[k]	-0.678[j]	-0.012	-0.008	0.061	0.018	0.108	0.000	0.322	0.326	0.025			
Thailand	0.379	0.283	-0.343	-0.022	0.000	0.569	0.771	0.410	0.392	0.000					
Americas	-0.171	-0.431	-0.802	-0.039	0.002										
Northern Africa	-0.150	-0.204	-0.684	-0.006	-0.004										
Sub-Saharan Africa	-0.082	-0.238	-0.499	-0.004	-0.001										
Asia	0.038	-0.190	-0.690	-0.004	-0.004										
Overall	-0.108	-0.297	-0.653	-0.017	-0.001										

Sources: Demographic and Health Surveys individual recode files.

NOTE: Second and higher order births, born 2-15 years before the survey.

[a]Reference group: Male children.

[b]Reference group: Second and third order births.

[c]Reference group: Mother aged 20-24 years at birth.

[d]Reference group: 24-47 months.

[e]Reference group: Preceding child alive at birth of index child.

[f]Reference group: All second births and third births associated with a surviving first birth.

[g]Reference group: No schooling.

[h]Measured in years since 1 January 1975.

[i]Reference group: Region with the lowest net child mortality.

[j]Significant at 1 per cent level.

[k]Significant at 5 per cent level.

over 4,000 births, with samples in excess of 10,000 for Egypt, Kenya and Indonesia. In total, survival information to age two for about 175,000 births of order two and above is analysed. The parameter estimates are also shown in table 42, the odds ratios in table 43, and the proportions of births in each category for each covariate in table 44.

Sex differentials

In 23 of the 25 countries ($p = 0.00001$) there is a net advantage in survival to age two for daughters, which averages about 16 per cent over all countries. These differences are not large and reach a 1 per cent level of statistical significance in 11 of the 25 countries. As can be seen from the regional averages, the female advantage is stronger than average for the three Asian countries included in the study, all of which have log odds which are significant at the 1 per cent level. The net survival advantage for girls is consistently very weak in the three Northern African countries. There is more variability within the countries from the Americas and from sub-Saharan Africa, although this may in part be attributable to the larger number of countries examined for these two regions.

Age of mother

The overall pattern of the log odds for mother's age is similar to that observed in the analysis of first births, although the excess mortality for those children born to mothers under age 18 is net of a wider range of factors, including previous birth interval and the survival status of the preceding birth. Even so, the overall average net excess mortality for children born to very young mothers is approximately 45 per cent and is positive for 22 of the 25 countries ($p=0.00008$). However, since second and higher order births to very young mothers (before age 18) are generally very rare (never more than 5 per cent of the total later births considered), few of the individual parameter estimates are statistically significantly different from the reference group of 20-24-year-old mothers. In view if this high variability around the parameter estimates it is unwise to try to make statements about broad regional patterns or individual country estimates. Nevertheless, the general and non-trivial survival disadvantage of children born to very young mothers is once again apparent and survives a fairly formidable set of controls for other correlates of child mortality.

There is also a strong suggestion that survival chances for children improve slowly with increasing age of mother beyond age 18 up to age 35. Compared with children born to 20-24-year-old mothers, the overall average deviations in the odds ratios suggest a 14 per cent net excess mortality for births to 18-19-year-olds, and seven and 11 per cent net survival advantages for those born to 25-29 and 30-34-year-old mothers respectively. In each of these contrasts with the 20-24 age group 18 or 19 of the parameter estimates have the same sign (positive for age group 18-19 and negative for age groups 25-29 and 30-34; $p<0.02$), which gives reasonable confidence that these weak and usually statistically significant effects are nevertheless real and pervasive. It is noted that departures from the "normal" pattern are slightly more frequent for countries from sub-Saharan Africa (e.g., Botswana with three (out of four) exceptions; Burundi, Togo and Thailand are the only other cases with two exceptions); these departures may be more related to data quality than to real biological and residual socio-economic differences.

Preceding birth interval

The next correlate considered is the association of mortality of an index birth with the interval from the preceding live birth. As usual, the excess mortality associated with short preceding birth intervals is pervasive and powerful. When this interval is less than 18 months, there is substantial net excess mortality in every country examined, with the lowest estimate of the log odds being 0.484 for Togo, corresponding to excess odds of death of about two thirds. The estimated differences from the reference group (an interval of 24-47 months) are statistically significant at the 1 per cent level in all countries except Trinidad and Tobago, which has the smallest sample size. The estimated excess is extremely high (log odds above 1.2; odds ratios above 3.3 to one) in four countries: Egypt, Tunisia, Mali and Guate-

TABLE 43. ODDS RATIOS, LATER BIRTHS MODEL

Country	Total births	Child's sex: female[a]	Birth order[a]: 4-6	Birth order[a]: 7+	Mother's age at birth[a]: <18	Mother's age at birth[a]: 18-19	Mother's age at birth[a]: 25-29	Mother's age at birth[a]: 30-34	Preceding birth interval[a] (months): <18	Preceding birth interval[a] (months): 18-23	Preceding birth interval[a] (months): 48-71	Preceding birth interval[a] (months): 72+	Survival status of preceding birth[a]: Dead	Survival status of preceding birth[a]: Maybe dead	Survival status of preceding birth[a]: Twin	Deaths for earlier births[a]: Of 3: 1	Deaths for earlier births[a]: Of 4-6: 1	Deaths for earlier births[a]: 2+	Deaths for earlier births[a]: Of 7+: 1	Deaths for earlier births[a]: 2	Deaths for earlier births[a]: 3 or more
Bolivia	9 318	0.840	1.069	1.503	1.120	1.155	0.838	0.682	2.436	1.632	0.605	0.569	1.427	5.211	1.306	1.020	1.335	1.222	1.123	0.917	0.906
Brazil	5 513	0.780	0.921	0.834	1.226	1.405	1.008	0.847	2.223	1.592	1.233	0.536	1.956	7.505	0.484	1.837	1.196	1.998	1.625	1.912	2.723
Colombia	4 060	0.976	1.157	1.348	1.647	1.134	0.811	1.232	2.356	1.307	0.468	0.829	1.746	4.513	1.757	1.562	1.197	1.710	1.034	0.774	1.748
Domican Republic	7 773	0.783	0.789	0.901	1.318	0.896	0.954	0.970	2.358	1.369	0.922	1.503	2.080	4.075	0.627	1.339	1.542	2.345	1.502	1.277	1.470
Ecuador	4 878	0.833	1.123	1.235	1.277	0.983	0.915	0.732	2.299	1.036	0.522	1.132	1.713	2.242	2.136	2.205	1.206	1.063	0.833	1.301	1.073
Guatemala	7 357	0.787	0.920	1.235	1.525	1.447	1.157	0.983	3.358	1.698	0.820	1.375	1.549	2.733	0.672	1.905	1.657	1.828	0.776	1.361	1.755
Mexico	8 763	0.698	1.467	1.551	1.961	1.380	0.863	0.650	2.020	1.404	0.814	0.612	1.007	2.913	0.722	1.966	1.342	1.329	1.075	1.235	2.602
Peru	5 352	0.907	1.129	1.354	1.633	1.192	0.895	0.867	2.361	1.542	0.656	0.295	1.678	3.479	1.405	0.712	1.039	0.738	0.508	1.279	0.878
Trinidad and Tobago	2 726	0.866	1.165	0.280	4.185	1.698	1.056	0.864	1.683	0.839	0.891	1.000	1.075	1.000	1.000	0.755	3.637	0.861	4.187	41.168	1.000
Egypt	14 156	1.035	1.082	0.996	1.252	1.110	0.828	1.024	3.612	1.862	0.559	0.867	1.318	2.073	1.154	1.642	1.322	1.175	1.174	1.944	1.767
Morocco	10 181	0.898	1.039	1.005	1.397	1.314	0.995	0.984	2.291	1.312	0.480	0.547	1.677	2.242	0.827	1.430	1.233	1.779	1.289	1.268	1.591
Tunisia	6 774	0.927	1.322	1.407	2.716	1.230	0.945	0.752	3.853	1.640	0.803	1.056	1.269	4.573	1.690	1.761	1.675	1.501	1.393	1.588	1.366
Botswana	4 375	0.737	1.089	0.927	1.611	0.728	1.049	1.022	2.377	1.564	0.971	0.753	1.826	1.495	0.332	3.435	1.443	1.212	0.899	1.833	1.000
Burundi	5 113	0.798	1.123	1.174	0.999	0.980	0.852	0.756	1.810	1.423	0.635	0.618	1.706	2.933	1.951	1.218	1.287	1.406	1.380	1.497	3.992
Ghana	5 548	0.881	1.072	1.061	1.708	1.048	0.932	0.995	1.814	1.556	0.865	0.998	1.550	1.553	0.871	1.298	1.086	1.220	1.293	0.910	0.730
Kenya	11 145	0.938	0.848	1.079	0.892	1.113	0.823	0.889	2.047	1.462	0.671	0.411	2.589	3.370	1.084	1.411	1.557	1.216	1.154	1.196	0.853
Liberia	6 820	0.817	0.819	0.910	1.348	1.049	0.892	0.926	1.878	1.476	0.678	0.349	2.147	4.357	1.067	1.213	1.294	1.471	0.988	1.657	1.030
Mali	5 376	0.904	0.951	0.948	1.009	1.402	1.052	0.945	3.520	1.690	0.574	0.583	1.450	2.021	1.437	1.313	1.103	1.323	1.076	1.176	1.258
Senegal	6 330	0.892	0.967	0.922	1.570	1.080	0.934	1.131	1.730	1.449	0.732	0.599	1.674	2.333	0.332	1.064	1.692	1.176	0.966	1.189	2.361
Togo	4 338	1.095	0.821	1.131	0.825	1.448	0.948	1.023	1.622	1.208	0.617	1.258	2.009	1.388	0.844	1.119	1.260	1.918	1.250	0.891	0.996
Uganda	6 786	0.891	0.881	0.697	1.133	1.144	1.107	0.930	2.088	1.600	0.832	0.718	1.771	1.574	1.651	0.604	1.361	1.481	1.200	1.905	1.956
Zimbabwe	5 108	0.683	1.249	2.090	1.322	0.851	0.742	0.615	2.387	1.391	0.890	1.360	1.484	2.732	0.885	1.007	1.204	0.327	0.717	1.440	0.456
Indonesia	15 103	0.761	0.997	1.235	1.386	1.235	0.905	0.842	2.141	1.414	0.696	0.783	1.586	2.862	1.660	1.366	1.467	1.573	1.223	1.828	1.353
Sri Lanka	6 339	0.699	0.928	0.956	1.601	0.723	0.970	0.803	2.453	1.652	1.086	1.440	1.792	1.372	1.402	4.140	2.293	2.081	1.818	2.311	1.507
Thailand	5 841	0.676	0.945	1.927	1.957	1.525	1.013	1.214	2.617	1.528	0.571	1.245	0.796	8.090	0.723	0.757	1.506	2.904	0.747	1.332	0.882
Americas	55 740	0.826	1.067	1.035	1.622	1.232	0.939	0.854	2.309	1.350	0.739	0.780	1.540	3.813	1.002	1.373	1.459	1.361	1.173	1.801	1.512
Northern Africa	31 111	0.952	1.148	1.121	1.681	1.215	0.920	0.912	3.171	1.588	0.600	0.794	1.411	2.770	1.173	1.605	1.398	1.464	1.282	1.576	1.566
Sub-Saharan Africa	60 939	0.857	0.972	1.050	1.205	1.064	0.927	0.912	2.075	1.476	0.736	0.701	1.793	2.213	0.909	1.243	1.317	1.183	1.074	1.327	1.236
Asia	27 283	0.711	0.956	1.316	1.631	1.108	0.962	0.936	2.396	1.528	0.756	1.120	1.313	3.167	1.190	1.624	1.718	2.119	1.184	1.779	1.216
Overall	175 073	0.838	1.024	1.082	1.448	1.145	0.934	0.893	2.308	1.448	0.721	0.782	1.589	2.853	1.002	1.372	1.420	1.369	1.146	1.566	1.365

TABLE 43 (*continued*)

Country	Mother's education[a] (in years)			Region[b]									
	1-3	4-6	7+	1	2	3	4	5	6	7	8	9	10
Bolivia	0.795	0.687	0.385	1.530	1.276	1.000							
Brazil	0.964	0.821	0.507	1.250	1.376	1.093	1.000	2.537	1.125				
Colombia	0.716	0.472	0.466	1.411	1.762	1.634	1.710	1.000					
Dominican Republic	0.790	0.782	0.559	1.257	1.300	1.066	1.000	1.080	1.073	1.458	1.234		
Ecuador	0.660	0.474	0.386	1.000	1.345	1.871	1.007	1.572	1.395				
Guatemala	0.815	0.708	0.290	1.240	1.703	1.210	1.399	1.000	1.379	1.397			
Mexico	0.778	0.621	0.450	1.330	1.364	1.329	1.182	1.000	1.586	2.155	1.470	1.599	
Peru	0.964	0.774	0.393	1.000	1.438	2.409	2.090						
Trinidad and Tobago	1.228	0.619	0.728	1.611	1.000								
Egypt	0.929	0.984	0.409	1.000	1.083	1.285	1.380	1.793					
Morocco	0.826	0.650	0.471	2.254	1.605	1.000	1.562	1.639	1.205	1.374			
Tunisia	0.830	0.848	0.667	1.000	1.181	2.150	2.078	1.450	2.278				
Botswana	0.775	0.804	0.801										
Burundi	1.151	0.893	0.394	1.942	1.515	1.000	1.621	1.629					
Ghana	0.771	1.186	0.920	1.216	1.914	1.006	1.005	1.232	1.079	1.000	1.734		
Kenya	0.820	0.726	0.522	1.917	1.376	3.141	1.556	3.407	1.000	2.697			
Liberia	0.974	0.746	0.639	1.322	1.000	1.160	1.070						
Mali	0.689	0.680	0.537	1.693	1.566	2.235	1.000						
Senegal	0.940	0.520	0.613	1.000	1.069	1.081	1.360						
Togo	0.851	0.788	0.368	1.085	1.200	1.052	1.000	1.331					
Uganda	1.189	0.910	0.750	1.215	1.028	1.046	1.307	1.000	1.105				
Zimbabwe	1.219	0.793	0.772	2.516	1.898	1.779	1.532	2.203	1.715	1.590	1.585	1.429	1.000
Indonesia	0.859	0.674	0.351	1.000	1.115	1.006							
Sri Lanka	0.893	0.633	0.508	1.063	1.018	1.114	1.000	1.380	1.386	1.025			
Thailand	1.460	1.327	0.710	1.767	2.162	1.506	1.480	1.000					
Americas	0.843	0.650	0.448										
Northern Africa	0.860	0.816	0.505										
Sub-Saharan Africa	0.921	0.788	0.607										
Asia	1.039	0.827	0.502										
Overall	0.898	0.743	0.520										

Sources: Demographic and Health Surveys individual recode files.

NOTE: Second and higher order births, born 2-15 years before the survey.

[a]Reference group: Male children.

[b]Reference group: Second and third order births.

[c]Reference group: Mother aged 20-24 years at birth.

[d]Reference group: 24-47 months.

[e]Reference group: Preceding child alive at birth of index child.

[f]Reference group: All second births and third births associated with a surviving first birth.

[g]Reference group: No schooling.

[h]Reference group: Region with the lowest net child mortality.

TABLE 44. PROPORTION OF BIRTHS IN EACH RISK GROUP, LATER BIRTHS MODEL

Country	Total births	Child's sex female[a]	Birth order[b]		Mother's age at birth[c]				Preceding birth interval[d] (months)				Survival status of preceding birth[e]			Deaths for earlier births[f]					
			4-6	7+	<18	18-19	25-29	30-34	<18	18-23	48-71	72+	Dead	Maybe dead	Twin	Of 3 1	Of 4-6 1	2+	Of 7+ 1	2	3 or more
Bolivia	9 318	0.493	0.380	0.107	0.021	0.062	0.343	0.262	0.205	0.195	0.093	0.049	0.129	0.015	0.005	0.023	0.081	0.028	0.030	0.020	0.013
Brazil	5 513	0.501	0.327	0.131	0.020	0.056	0.377	0.223	0.328	0.187	0.085	0.048	0.109	0.006	0.009	0.027	0.080	0.019	0.032	0.021	0.020
Colombia	4 060	0.477	0.327	0.104	0.028	0.068	0.334	0.224	0.241	0.205	0.114	0.061	0.066	0.002	0.007	0.016	0.056	0.008	0.025	0.010	0.004
Dominican Republic	7 773	0.488	0.374	0.154	0.040	0.086	0.317	0.212	0.271	0.201	0.083	0.042	0.078	0.005	0.010	0.017	0.071	0.015	0.041	0.019	0.011
Ecuador	4 878	0.476	0.355	0.116	0.025	0.071	0.328	0.226	0.261	0.188	0.091	0.044	0.097	0.008	0.008	0.024	0.072	0.020	0.030	0.015	0.016
Guatemala	7 357	0.483	0.397	0.098	0.032	0.079	0.342	0.200	0.187	0.194	0.086	0.032	0.116	0.012	0.004	0.022	0.083	0.022	0.033	0.013	0.011
Mexico	8 763	0.489	0.353	0.134	0.032	0.076	0.333	0.235	0.245	0.207	0.096	0.043	0.073	0.002	0.008	0.016	0.067	0.011	0.042	0.017	0.007
Peru	5 352	0.491	0.375	0.134	0.019	0.058	0.346	0.265	0.237	0.207	0.084	0.038	0.108	0.005	0.007	0.018	0.077	0.020	0.042	0.025	0.012
Trin and Tobago	2 726	0.496	0.296	0.066	0.025	0.075	0.336	0.196	0.260	0.191	0.115	0.091	0.043			0.014	0.035	0.008	0.011	0.005	
Egypt	14 156	0.489	0.390	0.137	0.034	0.067	0.349	0.236	0.259	0.175	0.098	0.037	0.122	0.036	0.013	0.026	0.102	0.027	0.041	0.025	0.021
Morocco	10 181	0.486	0.412	0.146	0.021	0.052	0.349	0.254	0.207	0.203	0.066	0.023	0.113	0.013	0.012	0.024	0.088	0.024	0.044	0.021	0.015
Tunisia	6 774	0.498	0.390	0.093	0.002	0.018	0.410	0.292	0.236	0.202	0.079	0.026	0.071	0.010	0.011	0.016	0.068	0.014	0.028	0.013	0.010
Botswana	4 375	0.515	0.367	0.048	0.019	0.065	0.335	0.204	0.076	0.142	0.138	0.048	0.062	0.004	0.011	0.010	0.050	0.009	0.015	0.004	
Burundi	5 113	0.492	0.399	0.080	0.011	0.038	0.377	0.262	0.128	0.193	0.073	0.021	0.137	0.031	0.007	0.023	0.075	0.017	0.022	0.011	0.006
Ghana	5 548	0.482	0.399	0.089	0.024	0.055	0.346	0.249	0.098	0.146	0.121	0.038	0.113	0.034	0.014	0.024	0.083	0.019	0.027	0.011	0.006
Kenya	11 145	0.499	0.418	0.145	0.037	0.078	0.316	0.216	0.157	0.209	0.077	0.031	0.073	0.007	0.010	0.014	0.056	0.011	0.034	0.013	0.006
Liberia	6 820	0.494	0.385	0.121	0.050	0.097	0.296	0.209	0.188	0.205	0.089	0.039	0.206	0.026	0.018	0.040	0.108	0.054	0.030	0.023	0.029
Mali	5 376	0.475	0.411	0.143	0.050	0.083	0.314	0.218	0.213	0.192	0.078	0.036	0.126	0.134	0.009	0.040	0.111	0.040	0.046	0.026	0.013
Senegal	6 330	0.483	0.408	0.124	0.040	0.086	0.312	0.216	0.102	0.193	0.062	0.020	0.154	0.049	0.009	0.028	0.089	0.019	0.033	0.018	0.010
Togo	4 338	0.488	0.418	0.092	0.026	0.066	0.335	0.236	0.095	0.146	0.102	0.027	0.092	0.060	0.020	0.026	0.086	0.021	0.028	0.015	0.009
Uganda	6 786	0.505	0.408	0.152	0.045	0.100	0.295	0.193	0.145	0.231	0.068	0.021	0.132	0.014	0.011	0.022	0.076	0.015	0.042	0.015	0.009
Zimbabwe	5 108	0.485	0.401	0.105	0.026	0.064	0.337	0.230	0.096	0.166	0.096	0.034	0.080	0.005	0.018	0.017	0.062	0.008	0.030	0.008	0.003
Indonesia	15 103	0.484	0.361	0.088	0.026	0.067	0.333	0.230	0.159	0.179	0.112	0.053	0.097	0.018	0.005	0.023	0.067	0.017	0.026	0.011	0.007
Sri Lanka	6 339	0.488	0.301	0.052	0.009	0.031	0.389	0.291	0.145	0.185	0.111	0.051	0.044	0.005	0.008	0.012	0.033	0.005	0.010	0.001	0.002
Thailand	5 841	0.490	0.280	0.043	0.010	0.045	0.366	0.257	0.168	0.165	0.133	0.074	0.051	0.012	0.005	0.021	0.046	0.011	0.012	0.005	0.004
Americas	55 740	0.488	0.354	0.116	0.027	0.070	0.340	0.227	0.248	0.197	0.094	0.050	0.091	0.007	0.007	0.020	0.069	0.017	0.032	0.016	0.012
Northern Africa	31 111	0.491	0.397	0.125	0.019	0.045	0.369	0.261	0.234	0.193	0.081	0.028	0.102	0.020	0.012	0.022	0.086	0.022	0.037	0.020	0.015
Sub-Saharan Africa	60 939	0.492	0.402	0.110	0.033	0.073	0.326	0.223	0.130	0.182	0.090	0.031	0.118	0.036	0.013	0.024	0.080	0.021	0.031	0.014	0.010
Asia	27 283	0.487	0.314	0.061	0.015	0.048	0.363	0.259	0.158	0.176	0.118	0.059	0.064	0.012	0.006	0.019	0.048	0.011	0.016	0.006	0.005
Overall	175 073	0.490	0.373	0.108	0.027	0.066	0.341	0.233	0.188	0.188	0.094	0.041	0.100	0.021	0.010	0.022	0.073	0.018	0.030	0.015	0.011

TABLE 44 (*continued*)

Country	Mother's education[a] (in years)			Time[b]	Region[c]									
	1-3	4-6	7+	Linear	1	2	3	4	5	6	7	8	9	10
Bolivia	0.308	0.207	0.231	6.112	0.384	0.316	0.301							
Brazil	0.397	0.266	0.146	3.421	0.084	0.098	0.108	0.159	0.428	0.124				
Colombia	0.420	0.275	0.160	3.676	0.262	0.218	0.219	0.185	0.116					
Dominican Republic	0.405	0.281	0.183	3.368	0.122	0.086	0.134	0.123	0.141	0.102	0.188	0.105		
Ecuador	0.273	0.379	0.203	3.827	0.084	0.097	0.287	0.134	0.135	0.263				
Guatemala	0.238	0.119	0.043	5.009	0.192	0.133	0.245	0.143	0.086	0.095	0.107			
Mexico	0.299	0.339	0.164	3.795	0.088	0.081	0.156	0.084	0.152	0.098	0.104	0.083	0.154	
Peru	0.300	0.218	0.253	3.465	0.215	0.258	0.400	0.127						
Trinidad and Tobago	0.063	0.375	0.544	4.551	0.355	0.645								
Egypt	0.131	0.194	0.079	5.573	0.198	0.094	0.309	0.120	0.279					
Morocco	0.030	0.060	0.030	4.155	0.119	0.129	0.259	0.210	0.142	0.070	0.072			
Tunisia	0.070	0.192	0.078	5.538	0.147	0.164	0.164	0.181	0.180	0.165				
Botswana	0.117	0.208	0.337	5.825	1.000									
Burundi	0.081	0.102	0.038	4.776	0.179	0.108	0.085	0.478	0.149					
Ghana	0.070	0.102	0.308	5.356	0.088	0.116	0.102	0.145	0.101	0.184	0.127	0.137		
Kenya	0.102	0.208	0.311	6.034	0.072	0.178	0.102	0.127	0.195	0.166	0.159			
Liberia	0.057	0.076	0.118	3.561	0.180	0.203	0.182	0.435						
Mali	0.031	0.066	0.045	4.328	0.264	0.390	0.199	0.146						
Senegal	0.024	0.074	0.039	3.658	0.342	0.366	0.154	0.137						
Togo	0.077	0.118	0.045	5.706	0.398	0.221	0.102	0.127	0.151					
Uganda	0.166	0.234	0.169	6.061	0.038	0.181	0.314	0.041	0.339	0.088				
Zimbabwe	0.157	0.302	0.318	5.928	0.146	0.073	0.142	0.136	0.045	0.061	0.142	0.125	0.068	0.061
Indonesia	0.220	0.391	0.174	4.386	0.642	0.248	0.110							
Sri Lanka	0.162	0.284	0.416	3.745	0.088	0.133	0.115	0.166	0.198	0.136	0.165			
Thailand	0.060	0.707	0.122	3.531	0.167	0.234	0.215	0.245	0.140					
Americas	0.300	0.273	0.214	4.136										
Northern Africa	0.077	0.148	0.062	5.089										
Sub-Saharan Africa	0.088	0.149	0.173	5.123										
Asia	0.148	0.460	0.237	3.887										
Overall	0.170	0.231	0.182	4.615										

Sources: Demographic and Health Surveys individual recode files.

NOTE: Second and higher order births, born 2-15 years before the survey.

[a]Reference group: Male children.

[b]Reference group: Second and third order births.

[c]Reference group: Mother aged 20-24 years at birth.

[d]Reference group: 24-47 months.

[e]Reference group: Preceding child alive at birth of index child.

[f]Reference group: All second births and third births associated with a surviving first birth.

[g]Reference group: No schooling.

[h]Provides the average time of the sample of births, measured in years since 1 January 1975.

[i]Reference group: Region with the lowest net child mortality.

mala. (This contrasts with the overall average log odds of 0.84 and odds ratio of about 2.3.) The first three countries in this list will come as no surprise in the context of the results of the tabular and regression analyses so far. For the Latin American (thus excluding Trinidad and Tobago), Northern African and Asian countries included in this analysis the lowest estimated log odds is for Mexico at 0.7 (odds ratio 2.0 to 1). Five of the 10 sub-Saharan African countries have estimated log odds below this value: Liberia, Burundi, Ghana, Senegal and Togo. Excepting Mali, the largest estimated log odds for any sub-Saharan African countries (for Botswana and Zimbabwe) are only just above the overall average across all 25 countries. Thus the deleterious effects of very short birth intervals seem slightly weaker in sub-Saharan Africa and most particularly in the countries with high overall child mortality. This may reflect the fact that even the slightly lower odds ratios in these societies, when applied to much higher baseline rates, generate a larger absolute increase in the fraction dying.[3]

The excess mortality associated with a preceding birth interval of 18-23 months is lower, but nevertheless pervasive, with the log odds being positive in all countries except Trinidad and Tobago (sign test $p=0.000001$). These parameter estimates differ significantly from zero at the 5 per cent level in 21 of the 24 countries with positive coefficients. Taken overall, the net log odds across all 25 countries averages 0.37, corresponding to excess odds of death of about 45 per cent. Thus the disadvantage associated with a preceding birth interval of 18-23 months averages exactly the same as the disadvantage associated in this model with the mother being under age 18 at the time of the index birth. However, an unweighted average across all 25 countries of the proportions of births occurring in these risk groups is crudely informative: only 2.7 per cent of later births to mothers under the age of 35 years occur to those under age 18; 18.8 per cent of later births occur in the period from 18-23 months after the preceding birth and exactly the same unweighted overall fraction occur at intervals of less than 18 months. Evidently there will be a greater population impact for the spacing of births than for the age of the mother.

The estimated log odds for longer preceding birth intervals (in excess of four years) have greater variability than those for short intervals, being typically based on roughly half the sample size of the estimates for short intervals in the case of preceding intervals of 48-71 months and only about a quarter to a fifth of the sample size for intervals longer than six years. However, there is a consistent survival advantage associated with preceding birth intervals of four or five years, with the parameter estimates being negative for 23 of the 25 countries (the exceptions being Brazil and Sri Lanka; $p=0.00001$). The overall average log odds for this advantage is of similar magnitude but opposite sign to that for the intervals of 18-23 months. The pattern for births after even longer intervals (more than six years) is even more variable and only 16 parameter estimates are negative ($p=0.114$). The only broad region with these parameter estimates consistently negative is sub-Saharan Africa with 8 out of 10 negative; for the other areas only 8 of 15 are negative. Long inter-birth intervals are the exception in most third world countries and the proportion of preceding intervals of four to six years among these 25 countries varies from 6 to 14 per cent; the fractions at intervals of over six years run from 2 to 9 per cent of all later births. Few couples actively seek such long inter-birth intervals and most are probably either the result of low fecundability or of contraceptive failure. But there is a third likely source of very long preceding intervals being reported in retrospective surveys. This arises if there are differential omissions of dead children from retrospective birth histories. Such omissions will clearly lead to a misleadingly long inter-birth interval and reduce the mortality associated with such reported long intervals. It is suspected, but has not been demonstrated, that a significant fraction of very long apparent inter-birth intervals reported in societies with very little contraceptive use arises from such reporting errors; this fraction need not be very high (25 to 35 per cent) in order to wipe out the apparent survival advantage associated with this group.

Clustering of deaths

The analysis now turns to some information on previous mortality among the older siblings of the index child, or the observable prior information on the clustering of deaths within the family. First, the survival status of the immediately preceding birth at the time of birth of the index child is examined.

Where the preceding maternity resulted in multiple births it is no easy matter to decide upon a single survival status indicator and multiple births are simply identified as one category in the indications of survival status of the preceding birth. Of course, twin births are rare, constituting less than 1 per cent of the preceding maternities in most of the 25 countries considered here although being about double this level for Liberia, Togo and Zimbabwe. Very high standard errors on the parameter estimates can thus be expected for this group. For preceding singleton births, three survival status groups are distinguished: survivors; dead; and "maybe" dead. The maybe dead category is necessary for several reasons. First, the ages at death for the DHS are usually recorded in days within the first month of life, in months up to age two years and by completed years beyond the second birthday. There is thus some imprecision about the date of occurrence of a child death for the preceding birth; where this area of uncertainty overlaps the date of birth for the index child the survival status of the preceding birth is coded as maybe dead. Secondly, there is imprecision in the dating of some births which is identifiable on the individual recode files. Where machine imputation was used to impute partially missing information on the date of birth of either the index birth or of the preceding birth, the range of dates which were consistent with the original reported information have been recreated. This information was used in part one of the report to examine the links between imprecise dating and child survival, where it was shown that patterns of relative risks by length of the preceding birth interval hardly changed in most countries when confined to the more precisely dated intervals, despite a clear association of imprecise dating with child death. Once again, if the range of possible dates of death of a deceased preceding birth, taking account of the imprecision in the dating of that birth and of the age at death, overlapped with the range of possible dates for the index birth, the survival status of the preceding birth was set to "maybe". Thus, the only cases assigned to the alive (the reference group) or dead categories were those where the information recorded on the individual recode file permitted unambiguous assignment. Regrettably, it was not possible to make any allowances for imputation of dates or ages at death which occurred during the process of interview, or in field or office edits. However, this is probably the first systematic attempt to use the available information on precision of dating which is available to the analyst in machine-readable form.

In addition to examining the association between survival of the preceding birth, some further controls are introduced for the survival of any births before that one. Thus, for index births that are third births there is further information about the survival status of the first birth (as well as the second birth, which is already incorporated as the preceding birth). For these third births an additional indicator is added according to whether or not the first birth survived infancy. For fourth to sixth births, there are from two to four earlier births in addition to the preceding one; those cases where none, one, and two or more of these earlier births had died in infancy are now distinguished. Finally, for births of order seven and higher, those cases where none, one, two, and three or more of these earlier births had died as infants are identified. Of course, the general expectation would be that mortality of the index birth would be higher with every piece of additional evidence concerning mortality among its older siblings. There is clearly scope for further refinement of this analysis to handle clustering of mortality in time within the family by using time dependent covariates, but the measures defined here have the distinct advantage of being simple enough (with the evident exception of the careful treatment of imputation which is not relevant in this context) to be incorporated in obstetric and post-natal care to enable the identification of "high risk" families requiring greater education and health intervention.

Before turning to the results shown in table 42, it is noted that many of the categories used in this section of the analysis are quite rare (see table 44 for proportions in various risk groups). The unweighted averages across all 25 countries are used to make this point. For the survival status of the preceding birth, 87 per cent are alive; 10 per cent are dead, a further 2 per cent maybe dead and 1 per cent are twins. Of the total samples, 2.2 per cent of all later births are in the one earlier birth of three dying in infancy group; 7.3 per cent and 1.8 per cent of all later births in the one and two or more dead earlier births for index births of order four to six; and 3.0, 1.5, and 1.1 per cent of all later births are respectively in the one, two, and three or more dead categories for

index births of order seven or higher. Hence, samples are small and parameter estimates have large standard errors. It might also be expected that the population impact of these correlates is small, which is partly but not wholly true since the earlier births categories in total cover nearly 17 per cent of all index births.

Preceding birth

Not surprisingly, there is a clear and strong association between the death of an immediately preceding child before the birth of the index child and that index child's own survival chances. Taken over all 25 countries, the average log odds associated with a next older sibling's prior death is 0.463, corresponding to excess odds of death of almost 60 per cent for the index child. All the estimated log odds for this category are positive, with the exception of Thailand where the association of imprecise dating with child survival was shown to be strongest in part one of this report and where the parameter estimate associated with the maybe category on this variable is also extreme. For 21 of the 24 countries with positive log odds for the preceding child dead category the difference from the reference group (preceding child alive) is statistically significant at the 5 per cent level; the exceptions are Mexico, Trinidad and Tobago, and Tunisia.

The category of preceding children who "may be" dead contains much of the information about imprecise dating which was shown in part one of this report to be closely associated with the survival status of the child concerned. It is therefore only to be expected that a category which can be affected by the dating of the index birth as well as the preceding birth will experience considerable excess mortality. This is of no great relevance to the study of the correlates of child mortality except in so far as separate control for this "contamination" provides a little more confidence concerning rejection of the hypothesis that much of the observed pattern of association between length of the preceding interval and child survival is due to the association between poor dating and child survival. This is manifestly not the case for these regressions, where a control is introduced and a further explicit control for imprecision of the length of the preceding birth interval did nothing to alter the strong association between length of the preceding interval and child survival.

When the preceding birth was a multiple birth the estimated log odds of death for the index child fluctuate considerably and split about equally in sign and average close to zero.

Earlier births

Turning now to the estimated log odds associated with births earlier than the immediately preceding one, there is consistent evidence that the mortality of the index birth is correlated with the survival through infancy of these earlier births. As already indicated, this group of covariates is an explicit attempt to capture the evidence observable at the time of the index birth on the clustering of deaths within families. As expected, earlier deaths among the older siblings are generally associated with higher mortality for the index child. It was expected that the excess mortality for the index child would increase with increasing numbers of earlier dead children. This expectation is not really met by the results of these analyses, although the large variability in the parameter estimates, which is almost certainly largely attributable to small samples, means that averages across all countries could be unreliable.

For index children who are third births, the odds of death are increased by about one third if the first-born child died, compared with the reference group in this context, which contains all second births and those third births associated with a surviving first birth. For fourth to sixth births, where all "earlier" births survived infancy (labelled "birth order four to six" in table 42), there is a negligible mortality difference compared with the same reference group of second births and those third births where the first-born survived infancy. Similarly, for seventh and higher order births where no earlier child died in infancy (putative strong evidence for an advantaged family survival background), there is negligible indication of excess mortality. For fourth to sixth births where one earlier birth had died in infancy, the overall average odds of death are increased by about 42 per cent, compared with the same second and

third birth reference group; if two or more of the two to four earlier births had died in infancy, this is again associated with a similar, perhaps slightly lower, level of excess mortality for the index child. Where the index child is a seventh or higher order birth, one death among the five or more earlier births is only and unsurprisingly associated with a small average excess mortality for the index child; the average increase when two of these children had died in infancy is somewhat larger, being equivalent to a 57 per cent increase in the odds of death before age two for the index child; however, if three or more of these earlier births died in infancy, the overall excess odds of death is again about 36 per cent. It is further noted that the log odds associated with all the categories identifying non-surviving earlier births are generally positive, with no fewer than 18 being positive in each case and often more ($p < 0.02$ for each set of parameter estimates).

Comparing these results on "earlier" birth effects with those for the preceding birth, the slightly larger value for the latter indicator of death perhaps indicates that proximity in risks plays a part. However, it is entirely possible that some of the effects of the length of the preceding interval are being partly captured by the indication of survival of the preceding birth, since an early death will usually cause a shorter than average subsequent interval. In general there seems to be little additional leverage to be obtained in these samples by identifying the numbers of earlier births that had died. Perhaps parents with early infant deaths actively seek better attention and health care knowledge; possibly respondents become increasingly reluctant to report a string of deceased children; possibly clustering of deaths within families arises from cross-infections (e.g., measles - see Aaby, 1988) and thus occurs all at once, reducing possible explanatory power for subsequent survival chances in the family; and perhaps the survival experience of "earlier" births becomes progressively less relevant in periods of rapid change in child survival, both because the past health environment is no longer reflected in the current one and since higher order births inevitably occurred later in time than the lower order births. It is also possible that these results are biased as a consequence of selective omissions of dead children in high mortality families.

Mother's education

The relationship of child survival to mother's education is by now familiar. The association is powerful and pervasive and increases in strength with increasing levels of education. Effects are, once again, generally weaker for many of the sub-Saharan African countries. Perhaps most interesting is that the average survival advantages from the various levels of schooling are slightly lower than for first births; this may simply result in control for several variables which capture some information about survival of previous births, which are themselves affected by maternal education. Since maternal education usually is causally prior to such survival outcomes the gross effect might better capture the role of maternal education and a fuller understanding of these aspects would require the specification of path models.

Population impact

Table 45 shows the building blocks for the summary values of population attributable log odds or impact scores for each category of every variable incorporated in the later births model. As such it is an important reference table and some of the detailed values will be referred to during the discussion of population impacts. However, this welter of detail is further summarized in table 46, which shows the total impact scores for each variable, summed across all categories.

For a number of the variables considered in these analyses it is clear that the population impact is small. The average impact score across all 25 countries is below 0.1 (regardless of sign) for the sex of the index child, for birth order (excluding the earlier birth survival outcome effects which are crossed with birth order), teenage motherhood (too young), and the recent and earlier birth survival outcomes. Although these variables are not important at the population level, there is evidence of significant individual excess child mortality associated with entry into motherhood before age 18 and with negative preceding and earlier survival outcomes. All of these risk factors are important when monitoring the risks for individual children, but are

TABLE 45. POPULATION ATTRIBUTABLE LOG ODDS, LATER BIRTHS MODEL

Country	Child's sex female[a]	Birth order[b]		Mother's age at birth[c]				Preceding birth interval[d] (months)				Survival status of preceding birth[e]			Deaths for earlier births[f]					
		4-6	7+	<18	18-19	25-29	30-34	<18	18-23	48-71	72+	Dead	Maybe dead	Twin	Of 3 1	Of 4-6 1	2+	Of 7+ 1	2	3 or more
Bolivia	-0.086	0.025	0.044	0.002	0.009	-0.061	-0.100	0.183	0.095	-0.046	-0.028	0.046	0.024	0.001	0.000	0.023	0.006	0.004	-0.002	-0.001
Brazil	-0.125	-0.027	-0.024	0.004	0.019	0.003	-0.037	0.262	0.087	0.018	-0.030	0.073	0.013	-0.006	0.016	0.014	0.013	0.016	0.014	0.021
Colombia	-0.012	0.048	0.031	0.014	0.009	-0.070	0.047	0.206	0.055	-0.087	-0.011	0.037	0.003	0.004	0.007	0.010	0.004	0.001	-0.003	0.002
Dominican Republic	-0.119	-0.088	-0.016	0.011	-0.009	-0.015	-0.006	0.233	0.063	-0.007	0.017	0.057	0.007	-0.005	0.005	0.031	0.013	0.017	0.005	0.004
Ecuador	-0.087	0.041	0.025	0.006	-0.001	-0.029	-0.071	0.217	0.007	-0.060	0.005	0.052	0.006	0.006	0.019	0.014	0.001	-0.005	0.004	0.001
Guatemala	-0.116	-0.033	0.021	0.013	0.029	0.050	-0.004	0.227	0.103	-0.017	0.010	0.051	0.012	-0.001	0.014	0.042	0.013	-0.008	0.004	0.006
Mexico	-0.176	0.135	0.059	0.022	0.024	-0.049	-0.101	0.172	0.070	-0.020	-0.021	0.000	0.002	-0.003	0.011	0.020	0.003	0.003	0.004	0.007
Peru	-0.048	0.045	0.041	0.009	0.010	-0.038	-0.038	0.203	0.090	-0.035	-0.047	0.056	0.007	0.002	-0.006	0.003	-0.006	-0.029	0.006	-0.002
Trinidad and Tobago	-0.071	0.045	-0.084	0.036	0.040	0.018	-0.029	0.135	-0.034	-0.013	0.000	0.003	0.000	0.000	-0.004	0.045	-0.001	0.016	0.018	0.000
Egypt	0.017	0.031	-0.001	0.008	0.007	-0.066	0.006	0.333	0.109	-0.057	-0.005	0.034	0.026	0.002	0.013	0.029	0.004	0.007	0.017	0.012
Morocco	-0.052	0.023	0.001	0.007	0.014	-0.002	-0.004	0.171	0.055	-0.048	-0.014	0.058	0.011	-0.002	0.009	0.018	0.014	0.011	0.005	0.007
Tunisia	-0.038	0.109	0.032	0.002	0.004	-0.023	-0.083	0.319	0.100	-0.017	0.001	0.017	0.015	0.006	0.009	0.035	0.006	0.009	0.006	0.003
Botswana	-0.158	0.031	-0.004	0.009	-0.021	0.016	0.005	0.066	0.063	-0.004	-0.014	0.037	0.001	-0.012	0.012	0.018	0.002	-0.002	0.002	0.000
Burundi	-0.111	0.046	0.013	0.000	-0.001	-0.060	-0.073	0.076	0.068	-0.033	-0.010	0.073	0.033	0.005	0.005	0.019	0.006	0.007	0.004	0.009
Ghana	-0.061	0.028	0.005	0.013	0.003	-0.024	-0.001	0.059	0.065	-0.018	0.000	0.050	0.015	-0.002	0.006	0.007	0.004	0.007	-0.001	-0.002
Kenya	-0.032	-0.069	0.011	-0.004	0.008	-0.062	-0.025	0.112	0.079	-0.031	-0.027	0.070	0.008	0.001	0.005	0.025	0.002	0.005	0.002	-0.001
Liberia	-0.100	-0.077	-0.011	0.015	0.005	-0.034	-0.016	0.118	0.080	-0.035	-0.041	0.157	0.038	0.001	0.008	0.028	0.021	0.000	0.012	0.001
Mali	-0.048	-0.021	-0.008	0.000	0.028	0.016	-0.012	0.268	0.101	-0.043	-0.019	0.047	0.095	0.003	0.011	0.011	0.011	0.003	0.004	0.003
Senegal	-0.055	-0.014	-0.010	0.018	0.007	-0.021	0.027	0.056	0.072	-0.019	-0.010	0.079	0.041	-0.010	0.002	0.047	0.003	-0.001	0.003	0.009
Togo	0.044	-0.083	0.011	-0.005	0.024	-0.018	0.005	0.046	0.028	-0.049	0.006	0.064	0.020	-0.003	0.003	0.020	0.014	0.006	-0.002	0.000
Uganda	-0.058	-0.052	-0.055	0.006	0.013	0.030	-0.014	0.107	0.109	-0.012	-0.007	0.076	0.006	0.006	-0.011	0.023	0.006	0.008	0.010	0.006
Zimbabwe	-0.185	0.089	0.077	0.007	-0.010	-0.101	-0.112	0.084	0.055	-0.011	0.011	0.032	0.005	-0.002	0.000	0.012	-0.009	-0.010	0.003	-0.002
Indonesia	-0.133	-0.001	0.019	0.008	0.014	-0.033	-0.040	0.121	0.062	-0.040	-0.013	0.045	0.019	0.003	0.007	0.026	0.008	0.005	0.007	0.002
Sri Lanka	-0.175	-0.023	-0.002	0.004	-0.010	-0.012	-0.064	0.130	0.093	0.009	0.019	0.025	0.002	0.003	0.017	0.027	0.004	0.006	0.001	0.001
Thailand	-0.192	-0.016	0.028	0.007	0.019	0.005	0.050	0.162	0.070	-0.074	0.016	-0.012	0.024	-0.002	-0.006	0.019	0.011	-0.004	0.001	-0.001
Americas	-0.093	0.021	0.011	0.013	0.014	-0.021	-0.038	0.204	0.060	-0.030	-0.012	0.042	0.008	0.000	0.007	0.022	0.005	0.002	0.005	0.004
Northern Africa	-0.024	0.054	0.011	0.005	0.008	-0.030	-0.027	0.274	0.088	-0.041	-0.006	0.036	0.017	0.002	0.010	0.027	0.008	0.009	0.009	0.007
Sub-Saharan Africa	-0.076	-0.012	0.003	0.006	0.006	-0.026	-0.022	0.099	0.072	-0.026	-0.011	0.068	0.026	-0.001	0.004	0.021	0.006	0.002	0.004	0.002
Asia	-0.166	-0.013	0.015	0.006	0.008	-0.013	-0.018	0.138	0.075	-0.035	0.007	0.019	0.015	0.001	0.006	0.024	0.008	0.002	0.003	0.001
Overall	-0.087	0.008	0.008	0.009	0.009	-0.023	-0.028	0.163	0.070	-0.030	-0.008	0.049	0.017	0.000	0.006	0.023	0.006	0.003	0.005	0.003

TABLE 45 (*continued*)

Country	Mother's education[a] (in years)			10-year trend[b]		Region[c]									
	1-3	4-6	7+	Time	Time squared	1	2	3	4	5	6	7	8	9	10
Bolivia	-0.070	-0.077	-0.220	-0.082	0.041	0.163	0.077	0.000							
Brazil	-0.015	-0.052	-0.099	0.003	-0.487	0.019	0.031	0.010	0.000	0.398	0.015				
Colombia	-0.140	-0.207	-0.122	-0.492	0.216	0.090	0.123	0.108	0.099	0.000					
Dominican Republic	-0.095	-0.069	-0.106	-0.347	0.231	0.028	0.023	0.009	0.000	0.011	0.007	0.071	0.022		
Ecuador	-0.113	-0.283	-0.194	-0.255	0.016	0.000	0.029	0.180	0.001	0.061	0.087				
Guatemala	-0.049	-0.041	-0.054	-0.218	-0.055	0.041	0.071	0.047	0.048	0.000	0.031	0.036			
Mexico	-0.075	-0.162	-0.131	0.038	-0.243	0.025	0.025	0.045	0.014	0.000	0.045	0.080	0.032	0.072	
Peru	-0.011	-0.056	-0.236	-0.233	0.282	0.000	0.094	0.352	0.094						
Trinidad and Tobago	0.013	-0.180	-0.173	-1.935	1.677	0.169	0.000								
Egypt	-0.010	-0.003	-0.070	0.067	-0.521	0.000	0.008	0.078	0.039	0.163					
Morocco	-0.006	-0.026	-0.023	-0.221	-0.325	0.096	0.061	0.000	0.093	0.070	0.013	0.023			
Tunisia	-0.013	-0.032	-0.031	-0.039	-0.366	0.000	0.027	0.125	0.133	0.067	0.136				
Botswana	-0.030	-0.046	-0.075	0.185	-0.397										
Burundi	0.011	-0.012	-0.035	0.454	-1.071	0.119	0.045	0.000	0.231	0.073					
Ghana	-0.018	0.017	-0.026	-0.933	0.742	0.017	0.075	0.001	0.001	0.021	0.014	0.000	0.076		
Kenya	-0.020	-0.067	-0.202	-0.929	0.867	0.047	0.057	0.117	0.056	0.239	0.000	0.158			
Liberia	-0.002	-0.022	-0.053	0.065	-0.207	0.050	0.000	0.027	0.029						
Mali	-0.012	-0.025	-0.028	-0.197	-0.255	0.139	0.175	0.160	0.000						
Senegal	-0.002	-0.048	-0.019	-0.502	0.350	0.000	0.025	0.012	0.042						
Togo	-0.012	-0.028	-0.045	-0.114	-0.048	0.032	0.040	0.005	0.000	0.043					
Uganda	0.029	-0.022	-0.049	0.752	-0.528	0.007	0.005	0.014	0.011	0.000	0.009				
Zimbabwe	0.031	-0.070	-0.082	0.793	-0.822	0.135	0.047	0.082	0.058	0.036	0.033	0.066	0.058	0.024	0.000
Indonesia	-0.033	-0.154	-0.183	0.201	-0.395	0.000	0.027	0.001							
Sri Lanka	-0.018	-0.130	-0.282	-0.117	-0.796	0.005	0.002	0.012	0.000	0.064	0.044	0.004			
Thailand	0.023	0.200	-0.042	-0.216	-0.007	0.095	0.180	0.088	0.096	0.000					
Americas	-0.062	-0.125	-0.148	-0.391	0.186										
Northern Africa	-0.009	-0.020	-0.041	-0.064	-0.404										
Sub-Saharan Africa	-0.002	-0.032	-0.061	-0.042	-0.137										
Asia	-0.010	-0.028	-0.169	-0.044	-0.399										
Overall	-0.026	-0.064	-0.103	-0.171	-0.084										

Sources: Demographic and Health Surveys individual recode files.

NOTE: Second and higher order births, born 2-15 years before the survey.

[a]Reference group: Male children.

[b]Reference group: Second and third order births.

[c]Reference group: Mother aged 20-24 years at birth.

[d]Reference group: 24-47 months.

[e]Reference group: Preceding child alive at birth of index child.

[f]Reference group: All second births and third births associated with a surviving first birth.

[g]Reference group: No schooling.

[h]Measured in years since 1 January 1975.

[i]Reference group: Region with the lowest net child mortality.

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TABLE 46. SUMMARY OF IMPACT SCORES, LATER BIRTHS MODEL

Country	Birth order[a]	Mother's age at birth <20[b]	Preceding birth interval <24 months[c]	Survival status of preceding births[d]	Deaths for earlier births[e]	Mothers education[f]	Mother's education[g]	10-year trend[h]	Region[i]
Bolivia	0.069	0.026	0.278	0.071	0.030	-0.368	0.586	-0.041	0.240
Brazil	-0.051	0.026	0.349	0.079	0.093	-0.166	0.513	-0.484	0.472
Colombia	0.079	0.025	0.261	0.044	0.022	-0.469	0.294	-0.276	0.420
Dominican Republic	-0.105	0.005	0.296	0.060	0.074	-0.271	0.311	-0.117	0.170
Ecuador	0.066	0.015	0.224	0.064	0.034	-0.590	0.362	-0.239	0.358
Guatemala	-0.013	0.037	0.329	0.061	0.072	-0.144	1.095	-0.273	0.273
Mexico	0.194	0.064	0.243	0.000	0.047	-0.368	0.430	-0.205	0.338
Peru	0.086	0.026	0.293	0.065	-0.034	-0.303	0.630	0.049	0.539
Trinidad and Tobago	-0.038	0.077	0.102	0.003	0.074	-0.340	-0.022	-0.258	0.169
Egypt	0.030	0.021	0.441	0.062	0.081	-0.083	0.812	-0.454	0.286
Morocco	0.024	0.021	0.227	0.067	0.064	-0.054	0.698	-0.546	0.357
Tunisia	0.141	0.008	0.419	0.038	0.068	-0.076	0.328	-0.405	0.488
Botswana	0.028	-0.014	0.129	0.027	0.033	-0.150	0.071	-0.212	
Burundi	0.059	0.006	0.144	0.111	0.049	-0.036	0.895	-0.617	0.468
Ghana	0.033	0.018	0.123	0.063	0.021	-0.027	0.057	-0.191	0.204
Kenya	-0.058	0.015	0.192	0.079	0.038	-0.289	0.361	-0.062	0.674
Liberia	-0.088	0.028	0.198	0.197	0.068	-0.076	0.371	-0.141	0.107
Mali	-0.028	0.028	0.368	0.145	0.044	-0.065	0.556	-0.451	0.474
Senegal	-0.024	0.024	0.127	0.110	0.062	-0.069	0.420	-0.151	0.079
Togo	-0.071	0.021	0.073	0.080	0.041	-0.085	0.913	-0.161	0.121
Uganda	-0.107	0.016	0.216	0.087	0.042	-0.042	0.246	0.224	0.046
Zimbabwe	0.166	0.018	0.138	0.035	-0.007	-0.121	0.137	-0.029	0.538
Indonesia	0.017	0.030	0.183	0.066	0.054	-0.370	0.678	-0.194	0.028
Sri Lanka	-0.025	-0.003	0.223	0.030	0.056	-0.430	0.248	-0.913	0.132
Thailand	0.013	0.023	0.232	0.011	0.021	0.181	0.523	-0.222	0.459
Americas	0.032	0.033	0.264	0.050	0.046	-0.335	0.467	-0.205	0.331
Northern Africa	0.065	0.017	0.362	0.056	0.071	-0.071	0.613	-0.468	0.377
Sub-Saharan Africa	-0.009	0.016	0.171	0.093	0.039	-0.096	0.403	-0.179	0.301
Asia	0.002	0.017	0.213	0.036	0.044	-0.207	0.483	-0.443	0.206
Overall	0.016	0.022	0.232	0.066	0.046	-0.192	0.461	-0.255	0.310

Sources: Demographic and Health Surveys individual recode files.

[a]Reference group: Second and third order births.
[b]Reference group: Mother aged 20-34 at birth.
[c]Reference group: 24-47 months.
[d]Reference group: Preceding child alive at birth of index child.
[e]Reference group: All second births and third births associated with a surviving first birth.
[f]Reference group: No schooling.
[g]Reference group: Seven or more years of schooling.
[h]Measured in years since 1 January 1975.
[i]Reference group: Region with the lowest net child mortality.

not on their own likely to make a major contribution to lowering mortality for populations. Significant average gains at the population level do appear to be plausible through improved child-spacing (perhaps a maximum 21 per cent gain if all births at intervals of less than two years were avoided - an implausible scenario), reduction of regional variation by bringing all regions up to the best (perhaps a maximum reduction of 27 per cent), and through ensuring that all mothers attain seven or more years of schooling (with a maximum gain of the order of 37 per cent). These figures for hypothetical possible reductions in child mortality can be contrasted with the average estimated achieved reduction in the odds of child death over the 10 years from January 1975 to January 1985 of some 22.5 per cent.

The information on survival outcomes of older siblings is separated into two components: the immediately preceding birth and earlier births. For the preceding birth the population impact scores are generally fairly low and only exceed 0.1 (corresponding to about a 10 per cent excess mortality) for Burundi, Liberia and Mali. For the earlier births there is no country with a population impact as high as 0.1.

There are suggestions of an unusual excess mortality associated with births of order four or higher where "earlier" births had all survived infancy in Mexico, Tunisia and Zimbabwe. These higher order births in lower mortality families have an apparent survival advantage in Dominican Republic and Uganda.

The estimated net 10-year change in survival odds varies considerably among the countries examined. Reductions of over a third in overall mortality for later births by age two are suggested for Brazil, Egypt, Morocco, Tunisia, Burundi, Mali and Sri Lanka. The estimated net reduction for Sri Lanka is fully 60 per cent, which seems a little implausible in view of civil unrest during the later part of this decade. Moreover, skepticism concerning data quality in Mali has already been expressed. The consistently high gains for the Northern African countries are interesting. A net rise (of 25 per cent) over this 10-year period (1975-1985) is suggested for Uganda, which seems plausible given civil unrest, and very little overall net change for Bolivia, Dominican Republic, Peru, Kenya and Zimbabwe. Elsewhere the changes are moderate, with net reductions ranging from 15 to 30 per cent.

There are three variables other than time trends associated with larger average population impacts: birth-spacing; maternal education; and regional variation within countries.

Birth-spacing

Except for Trinidad and Tobago, the lowest impact score for short preceding birth intervals (of less than two years) among the countries of the Americas is 0.224 in Ecuador (an impact score of 0.224 corresponds to an excess mortality of about 25 per cent). Among the sub-Saharan African countries, except Mali the highest impact score for close spacing is 0.216 for Uganda. Thus, a startlingly clear differentiation emerges between these two broad regions in the population impact associated with poor spacing. The Latin American countries typically exhibit higher proportions of births in the high risk group than do the sub-Saharan African countries; moreover the excess mortality risks are also usually greater for the countries of Latin America. Perhaps more strikingly still the population impact scores associated with births occurring too soon after the preceding one are higher for Egypt, Tunisia and Mali than for any country in the Americas. The three countries of Asia (which are not a good representation of this large and diverse continent) all have impact scores that place them approximately between the countries of Latin America and those from sub-Saharan Africa.

Mother's education

In order to assess the population impact of maternal education two sets of scores are provided in table 46. The first estimates the "gains" that have been achieved in each country compared with the hypothetical situation that everyone had had no education and assuming that the no-education risks would apply in such circumstances - clearly an implausible assumption for Trinidad and Tobago, where only

1.8 per cent of the population of mothers having later births fell into this risk group. This set of estimated population attributable log odds are thus an attempt to address the question as to "how far each country has come" from a situation where all women had the lowest possible level of maternal education. The second set of population impact scores associated with maternal education pose the question as to "how far there is to go", in the sense of asking what the excess mortality risks (or more correctly odds) are from the failure to achieve seven or more years of schooling for all mothers.[6]

The countries which have come furthest through the combination of current educational structure with the parameter estimates for the different educational levels are Colombia, Ecuador and Sri Lanka, closely followed by Bolivia, Mexico and Indonesia. At the other extreme, the three Northern African countries and seven of the 10 sub-Saharan African countries show gains of less than 10 per cent. In sub-Saharan Africa, the gains for Zimbabwe and Botswana are also below 15 per cent and only Kenya has a moderately high impact score (-0.289, corresponding to about a 25 per cent reduction in mortality). These three countries have relatively very high levels of education (along with Ghana all have over 30 per cent of mothers of later births with seven or more years of education, a fraction only exceeded by Sri Lanka and Trinidad and Tobago among the 25 countries); but the differentials in log odds by maternal education are, as has been repeatedly observed in this report, weaker in the sub-Saharan African countries. Thailand is an outlier, since the estimated odds of death are higher for children born to mothers with one to six years of education than for those born to uneducated mothers. Among the countries of the Americas, Brazil and Guatemala have moved least far overall, and Colombia and Ecuador stand out at the other extreme; the remaining six countries from this region have improvement impact scores of about 0.3 or slightly better (corresponding to about a 25 per cent reduction in mortality).

In examining the question as to how far there is to go in terms of potential population impact scores from increasing maternal education levels to seven or more years for all, there are some striking differences from the gains so far, as ought to be expected. The largest overall potential gains from universal secondary education appear for Guatemala, Egypt, Burundi and Togo, all of which have impact scores in excess of 0.8, suggesting that the odds of death before age two are more than doubled in the population compared with what might be attained if all mothers had seven or more years of schooling (and the observed differentials still held). These are all countries where relatively low proportions of mothers in the sample of later births had experienced secondary level schooling and the differentials by level of education are large. It is the combined effect of these two elements which is indicated by the impact scores. The estimated excess mortality from lack of seven or more years of schooling for all mothers is also above two thirds at the population level for Bolivia, Brazil, Peru, Morocco, Mali, Indonesia and Sri Lanka. Thus there are major potential gains in child survival from more universal education of mothers in 11 of the 25 countries considered here. Indeed, there is a 25 per cent or more population excess odds of death in all but Trinidad and Tobago (which is not relevant), Botswana and Zimbabwe. Thus there are very strong indications that increasing maternal education, especially to encompass seven or more years of schooling, could provide major gains in child survival in most of the countries included in this study.

Region

The final variable included in the models for later births is the region within each country. Once again, the question is posed as to what the excess child mortality is at the population level compared with the hypothetical situation where every child experienced the net mortality risks of the best region in their country. The odds of death are over 50 per cent too high in this sense for Brazil, Colombia, Peru, Tunisia, Burundi, Kenya, Mali, Zimbabwe and Thailand. On the other hand regional differentiation (at least for the standard regions identified in the DHS individual recode files listed at table 31) is quite low for Dominican Republic, Ghana, and Trinidad and Tobago and is very modest indeed for the remaining five sub-Saharan African countries and for Indonesia and Sri Lanka. These findings on the extent of regional disparities in differing countries require further investigation in a separate study which examines the differentials in health inputs by region and also brings to bear ecological information.

H. Summary and conclusion

This part of the report has covered a wide range of quite complex results. A series of five sets of regression models have been considered. The first three models were simplified approximations to those used in three of the major comparative analyses carried out using data from WFS (Hobcraft, McDonald and Rutstein, 1983, 1984 and 1985). The other pair of models separated first births from subsequent ones. In this section the common patterns which emerge from these models are summarized in broad outline. The results are also backed up in part by the two important comparative studies of survival chances of children born in the five years before DHS (Bicego and Boerma, 1991; Boerma and Bicego, 1992).

In all models considered, maternal education appears as a very powerful and pervasive correlate of child survival. Consistent and new evidence strongly suggests that the advantages of having an educated mother are weaker in the sub-Saharan African countries included in this study than elsewhere. Indications were also found that the potential population level gains from universal provision of seven or more years of schooling might be greatest in the Northern African region, where educational levels were low and differentials fairly high. Moreover the association of child survival with maternal education remains strong in the face of a wide range of other controls, most notably in the socio-economic model where the gross associations with husband's characteristics (education and occupation) are weaker than with maternal education and the attenuation of the net effects is also much greater for the husband's characteristics.

Since interventions to improve levels of female education are desirable on several other grounds as well (e.g., to improve women's status and, quite likely, help to lower fertility), these nearly universal findings on association with child survival reinforce the importance of improving (and especially not dismantling) education systems.

Much more needs to be discovered about the pathways through which maternal education improves child health (for a recent review, see Hobcraft, 1992). Moreover and relatedly there is also a need to discover whether and how far the key benefits for child survival can be conveyed to those women with fewer years of schooling, whether inside or outside the formal education sector. Regrettably, the data from DHS do not permit any attempt to discover the roles of differing content of the curriculum or of informal education, especially on health.

For several of the countries examined in this study there were clear and striking indications of regional differences in child survival. These are presumed to have arisen in significant measure from differential health provision and to a lesser extent from variations in disease ecology. These clear patterns were contrasted with some results from WFS which suggested very little variation in child survival by type of place of residence. Again, these findings deserve more close attention than was possible in this study, requiring a series of fairly detailed country-specific analyses which pay close attention to health service inputs and disease ecologies but also consider possible regional variations in data quality.

The net time trends showed considerable variation among countries, but the net impact over a 10-year period averaged a 22 per cent reduction in child mortality, not captured by any of the other factors controlled.

The main focus of this study has been upon issues to do with the consequences (or more properly associations) of the timing of births for child survival. These issues have been addressed in a number of ways.

Teenage child-bearing, especially before age 18, was shown to be generally associated with excess child mortality. The excess risk for individual births was considerable, but no larger than that associated with moderately short birth intervals (of 18-24 months), and the proportions of births to very young mothers are not usually very high. As a consequence, a delayed entry into motherhood may help individual mothers to lower the risks significantly of

having their first child die (and may have subsequent reproductive benefits which have not been investigated here), but such a policy should not be expected to have a major impact on child survival at the population level. Of course, there may be other motives for advocating a delayed entry into motherhood, such as lowering fertility or increasing female autonomy.

As was also the case for the studies using the information from WFS, there was no clear evidence to support the notion that child mortality risks increase to any important extent with increasing birth order. The study of these issues was partly hampered by restriction of analysis to births occurring to mothers under age 35 at the time. However, there does not appear to be any direct child health justification for advocating that women have fewer births before age 35 provided that the births are well spaced. There is of course considerable health benefit to the mother from exposure to fewer maternities and the increased risk of maternal mortality with more births may have significant consequential effects for her children's subsequent survival chances; this question cannot be investigated using retrospective birth histories collected from surviving mothers, as is the case for WFS and DHS.

The analyses presented here, most particularly the later births model, address the question of clustering of deaths within the family in a novel and direct way which is potentially relevant to obstetric and postnatal care. Fairly clear indications were found of increased risk for the index child if any of its older siblings have died. Clear support for major clustering of deaths within families was not found, since the cumulative effect of more than one preceding death for the survival chances of the index child was not evident. There was also some indication that knowledge of a death of the immediately older sibling, before the birth of the index child, conveyed more information about the survival chances of the index child than did an indication of a death of even older siblings. It is speculated that this recency phenomenon could arise either through a rapidly improving general child survival environment (which the estimated time trends strongly suggested for several countries) or in part because the death of the immediately preceding birth contributed more directly to the mortality of the index child through inducing a short birth interval. These issues of death clustering merit further careful exploration.

In terms of possible implications for child survival, the spacing of births once again emerges as the most powerful and consistent correlate among the aspects of the health rationale for family planning. As has also been consistently found in analyses using information from WFS, the strong and very widespread association of short intervals since the preceding birth with raised mortality risks persists in the face of the wide range of controls introduced in these regression analyses and with the somewhat different controls used in the extensive comparative analysis of Boerma and Bicego (1992). The associations are now documented for such a large variety of societies in terms of birth interval patterns, health and contraceptive provision, and levels of human development that it is more or less implausible to attempt to ascribe the observed association to problems of data quality or of interplays between health and contraception.

The real problem with the health rationale for spacing of births is that there has been very little progress over the past decade towards clarifying the mechanisms that might be involved in causing an association between a short preceding birth interval and the survival of the index child. Several analyses based upon WFS data attempted to disentangle whether the association arose from maternal depletion or from sibling competition (e.g., Hobcraft, McDonald and Rutstein, 1985; Cleland and Sathar, 1984; the literature is reviewed by Hobcraft, 1987; and National Research Council, 1989; Miller, 1991).

The patterns of association with broad regional groupings identified in part from the WFS studies are confirmed and sharpened by this study. The Northern African countries are shown consistently to have large excess risks for poorly spaced birth and high proportions of births at risk. This combination results in very considerable excess mortality at the population level. Latin American countries also show evidence of considerable fractions of births which occur at intervals of less than two years after the preceding one and fairly high excess risks, resulting in quite substantial excess child mortality

risks at the population level. Patterns of birth-spacing are typically better in the Asian countries and in the sub-Saharan African countries and excess risks are also somewhat lower in several sub-Saharan African countries. As a consequence, the countries covered in these regions show only moderate excess child mortality from short birth intervals (about 20 per cent at the population level).

As was explored to some extent in part one of this report, the situation in sub-Saharan Africa leaves room for concern. Firstly, there is clear evidence emerging of a significant collapse of traditional post-partum taboos on resumption of intercourse following a birth in many African societies (see Lesthaeghe, 1989) and considerable concern that prolonged breast-feeding patterns may also erode. These changes could lead to a dramatic increase in the proportions of births which occur at short intervals, thus raising the size of the risk group. The second concern must be whether the differentials in child survival by length of the preceding interval will also widen, perhaps as a result of lower overall child mortality levels leaving more scope for the underlying disadvantages to show up.

Although the mechanisms involved are still poorly understood, a massive body of evidence has accumulated over the past decade, and is reinforced by this study, to indicate a clear, persuasive and strong excess risk of death for children born after short birth intervals. These findings thus constitute an important component of the health rationale for family planning. For the health of children it is birth-spacing which appears to be critical, along with avoidance of very early child-bearing. For the health of the mother, it is avoidance of repeated risks of pregnancy and births (not have "too many") which is probably the most important health rationale for family planning.

Thus, at the societal level, family planning can indeed save the lives of both mothers (by limiting the number of exposures to the hazards of pregnancy and childbirth) and of their children (through delaying child-bearing at least to age 18 and possibly to age 20, and more especially through achieving birth intervals of two years or more). These survival benefits can clearly be quite considerable and are very likely complemented by wider health benefits for the mother and child. The health rationale for family planning is thus a strong one. However, at the individual level, family planning programmes must be cautious about how the health rationale is conveyed, since there is always a risk that individual mothers who space their births at intervals of greater than two years do suffer child deaths. Nevertheless, the potential health gains from family planning are considerable in many societies and these benefits need stressing and translating to individual women and couples in an appropriate and sensitive way.

Family planning is one of several possible routes to improved child survival identified in this report. The potential gains from reducing regional disparities and from improving levels of maternal education are as large. Moreover, the improvements over time, net of all the factors controlled in this study, are also large. Major improvements in the health of children can result from improved timing of births, from maternal education, from attention to regional disparities in health provision and disease ecology; in addition there appear to be other gains over time which are not well-captured by the correlates studied here.

NOTES

[1]For a few countries, most notably Trinidad and Tobago, there were very few uneducated mothers in the sample. This means that the parameter estimate for uneducated mothers is unreliable. As a consequence, the estimated survival to age five may be unreliable. However, this will have only marginal impact on the calculated relative risks shown in table 26.

[2]Although detailed results are not shown here, the log odds for mothers with seven or more years of education are reduced on average by 28 per cent when the other socio-economic controls are introduced; for husbands with seven or more years of schooling the corresponding average reduction for the net effects is 60 per cent; for husbands in professional and clerical occupations the average attenuation of the gross effects after control for other socio-economic covariates is 71 per cent.

[3]Once again, the "impact" scores for the socio-economic factors are calculated as a comparison with the advantaged groups. Thus, for Bolivia, for mother's education the impact score is the sum of the individual education group impact scores (-0.031, -0.066, -0.260) minus the parameter estimate for children born to mothers with seven or more years of schooling (-0.896), giving a value of 0.538. An impact score of 0.538 roughly corresponds to odds of mortality of 1.71:1 compared with the most advantaged group, or put more loosely, a 71 per cent excess mortality. Put another way, if all women achieved seven or more years of schooling, there might be an overall

reduction in child mortality of about 42 per cent (100-100/171). Moreover, the total possible gain from improving maternal education is 0.896 (the parameter estimate for women with seven or more years of schooling). In Bolivia, this suggests that some 60 per cent of the possible gains still have to be made (0.538/0.896).

[3]In assessing the population "impact" of time trends the method of calculation is different from other factors. Time is set to be zero at 1 January 1975 and is measured in years. The parameter estimates for "linear" and "quadratic" are used to calculate a value 10 years later, at 1 January 1985. Thus, for Bolivia, the parameter estimate at time 10 years is 0.360 (10 x 0.848 + 100 x -0.00488). This is shown as the population attributable log odds or impact score for a 10-year trend.

[4]Mali and Trinidad and Tobago are unusual in this respect. Reduced differentials might be expected at very low levels of mortality, as in Trinidad and Tobago. The differentials in Mali are either extraordinarily large in absolute terms or, more plausibly, ascribable to the very poor dating and general data quality for this extremely poor country.

[5]It is noted that the method of construction generally implies that the sum of the absolute values of these two impact scores is equal to the absolute value of the parameter estimate for the mothers with seven or more years of schooling.

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